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Number 8

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New York, February 23, 1929

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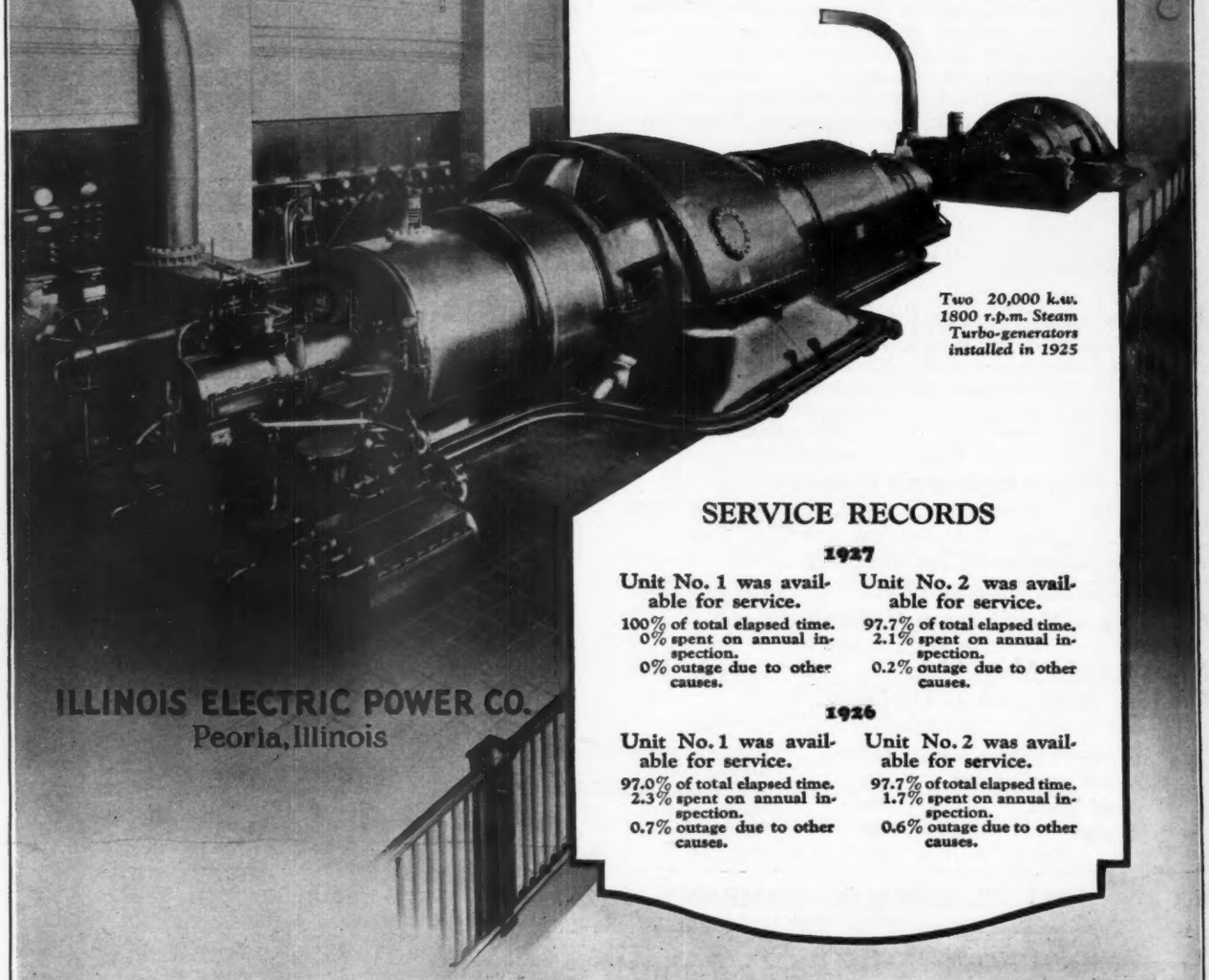

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Steel Makers Attack the Manganese Tariff

OPPOSITION of the domestic steel industry to the tariff on manganese ore, one of the raw materials it uses in making steel, finally came out into the open at the hearing before the Ways and Means Committee of the House on January 14—that is, if the filing of a brief without announcement may be called "coming out into the open."

The brief is signed by Mr. C. A. Buck, vice-president of the Bethlehem Steel Company, as spokesman for the steel manufacturers. At the same hearing, as announced in *Engineering and Mining Journal* of January 26, Mr. John A. Topping, vice-president of the American Iron and Steel Institute, appeared before the committee with a request for a readjustment upward of the present rates on iron and steel products. The inconsistency of these two appeals was pointed out in the editorial columns of the same issue.

Perusal of the brief filed by Mr. Buck brings out the following facts: First, the steel manufacturers choose wholly to ignore the factor of national preparedness against war with respect to manganese. Although they cannot make steel without manganese, which serves as a deoxidizer and a desulphurizer, they appear content to remain dependent on foreign sources for their supply of this commodity, despite the hazard that such dependence spells in case of war and the poor economic strategy it indicates with respect to peace. In seeking an explanation for this indifference the investigator should not overlook the fact that removal of the tariff would bankrupt the domestic manganese industry, thereby forcing the sale of manganese properties at a sacrifice. In such a contingency the steel companies would most probably be the buyers.

Second, Mr. Buck chooses to ignore the fact that, since the manganese tariff was established by the Fordney Act of 1922, much has been done to build up a domestic manganese industry in the United States. He says, "Under this excessive duty no development of a domestic industry in manganese ore has occurred." He prefers to shut his eyes to the enterprise of the Domestic Manganese & Development Company in Montana; to the promising results of the extensive research of Mr. Wilson Bradley, of Minneapolis; to the work of Mr. T. L. Joseph and his associates in the Minnesota Mines Experiment Station, which has for its objective the production of ferromanganese from low-grade manganiferous iron ores; and to the numerous manganese mining projects which various interests have entered upon, despite the eternal depressing threat that the tariff may possibly be removed. What development did Mr. Buck expect in the course of only seven years? If art be long, research is often longer, and the proper measure of its worthwhileness is the value of the objective. In the case of domestic manganese the national objective is no less than to insure the well-being in peace and the country's safety in war. The nation can afford to pay for such insurance.

And yet, what has the cost amounted to thus far? Mr. Buck says that in the past seven years the steel industry "has paid a tribute of over $50,000,000"—in the form of duties. He says that this is equivalent to an increase to his industry of about 30 per cent in the present corporation income tax, or to approximately 25 per cent of the industry's entire earnings available for holders of common stock. But he fails to show that the payment of this duty has decreased the earnings of the steel industry in any way. The duty has been paid by the consumer, whose tax rate tends to be lowered in turn by this addition to the federal income.

The "tribute" of $50,000,000, moreover, is made to appear an enormous toll. But it must be considered in connection with the steel output over which it has been spread. In the seven years in which it has been paid, the domestic steel manufacturers have produced almost 227,000,000 gross tons of rolled-steel products, valued approximately at twelve and a half billion dollars, to say nothing of the million and a quarter tons, approximately, of castings annually turned out. In the light of these really enormous figures, the duty is a very modest sum indeed.

The very essence of the principle of the protective tariff is that it shall serve to foster the development of infant industries. In the domestic manganese industry the people of the United States have an infant. Those who raise objection to the tariff that protects it should bear in mind that it costs something to have a baby, but that babies are usually held to justify the expenditure.

Exception may be taken to various other statements made in the brief filed by Mr. Buck. He says, "Substantial supplies of low-grade manganese ores do exist (in the United States), but are not suitable for the production of ferromanganese." This might well be qualified by saying that no economic process of making ferromanganese from them has thus far been developed, but that research is under way, which would be discouraged by the removal of the tariff. He says, further, that these low-grade ores have a definite present use in their natural condition in the production of a high-manganese pig iron. They have such use indeed, despite the fact that the steel industry once scoffed at the idea, and it is not at all improbable that, by leaching, the manganese contained in them can be made available in a form readily usable for making ferro.

Continuing, the brief declares: "A large source of our national wealth has been due to the existence and proper use of our natural resources." To this it may be said that no wealth has ever been made by leaving natural resources untouched and the uses for them undeveloped. Again,

it states: "The importation of manganese ore has been necessary since 1922 and will continue to be necessary." It will be necessary, however, to a gradually decreasing extent, if the domestic industry is allowed to grow, with a corresponding decrease in the country's dependence on other countries for so vital a commodity.

All in all, the brief portrays the steel producers as standing pat. They are against a tariff on anything they have to buy, just as they are for one on anything they have to sell. To secure their ends they blandly present specious argument as if it were self-evident truth, doubtless relying upon their influence in many channels to crush a small industry that seeks to grow in defiance of their wishes. It is hoped that Washington will properly appraise their attitude.

All Copper Production Facilities Now Being Utilized

WITH the receipt of the January copper production data, evidence accumulates that the industry throughout the world is operating at capacity, and that no further increase of moment may be expected without additional mine development or more equipment in the reduction plants. Though copper prices have risen continuously in the last five months, and have been sufficiently high to afford comfortable profits to all established producers, the January rate of world production—5,745 tons per day—is but 47 tons higher than that of last October. Temporary local difficulties have interfered somewhat with production in Chile and Peru; but, had they produced as expected, the daily rate would have been only 200 tons or so greater.

The larger producers have been chiefly responsible for the expansion of production. The high prices that were expected to make it possible for many small mines to operate have not had that effect to any marked extent, the output from the custom smelters in the United States showing practically no increase for several months. It is becoming more and more evident that the small producer is a negligible factor in the copper industry.

But the large companies cannot be accused of limiting production in an effort to secure even higher prices than have been ruling recently. Expansion to the extent of plant facilities has been general, even at the expense of mtallurgical recovery. For example, Utah Copper, which was outputting 36,000 tons of ore daily at the end of 1927, increased to 59,000 tons a day in the last quarter of 1928, though the mill recovery dropped from 89 to 80 per cent. It is evident that the heavy tonnage is being crowded through with, no doubt, insufficient grinding, in the effort to produce all the copper that consumers have come to require. Additional equipment is being installed at Utah Copper and by other important companies for the purpose of combining record production with a favorable metallurgical balance sheet.

At no time in its history has the copper industry been in a healthier state—capacity production, all of which is going into consumption; gradually increasing production facilities, consonant with expected requirements; and satisfactory prices without evidence of the runaway market that might easily have resulted had the conduct of the sellers been less intelligent.

Methods of a State Corporation Department

THE BIENNIAL REPORT of the California State Corporation Department, which administers the corporation securities law, is of interest to those who promote enterprises and to those who buy securities. Probably most significant is the tremendous volume of the securities authorized to be offered to the public in the two-year period—$2,886,302,288 in amount, in a state with a population of about 5,000,000. This includes sound securities as well as "speculative securities." No classification is made, and it is therefore impossible to gage the significance of this great sum. Nevertheless, the Commissioner reports that permits, involving authorization to sell stock, were revoked to the amount of $412,031,047, or about 14 per cent of the total for the period. As the amount authorized to be sold does not indicate the amount actually sold, presumably much less, the amount represented by the cancelled permits must bear a greater percentage to total sales than is represented by this 14 per cent. Of interest would be an estimate indicating the actual ratio of failures to commercial successes. No specific information is given about mining promotions. In fact, the report is open to criticism because of the lack of analysis of the status of enterprises that have received permits to sell securities.

Impropriety of Raising Money on a Layman's Report

IN NOVEMBER last we severely criticized the promotion methods of a mining company operating in Nevada, which, through an "Eastern Stockholders' Committee," was endeavoring to raise funds in Michigan, on the strength of statements and opinions issued by a professor of English at a prominent university, whose "report" was issued as "conclusive and final proof" that the enterprise was a "real business proposition of huge proportions, that the affairs of the Corporation are efficiently and economically conducted, and with a modern milling plant of adequate capacity to treat the ore the Corporation should soon be able to pay very handsome profits to stockholders."

Engineering and Mining Journal failed to discern in the literature any evidence of an expert survey and examination of the property by a qualified mining engineer, and we interpreted the appeal for funds as being based on unwarranted optimism. On publication of our criticism the Securities Commission of Michigan took immediate action through the State Geological Survey; and, so far as Michigan was concerned, a rebuke and a warning appeared to have produced salutary results. We hoped that the matter was closed, but a belated objection to our attitude now reaches us from the general manager of the company, at Reno, Nevada. "The professor's assistance," we are told, "was for the purpose of enhancing the value of his own investments and those of all the stockholders by aiding in raising the funds necessary for the mill. His every act and statement was for the good of all concerned and he had no interest or thought other-

wise. Therefore," we are chided, "the reflections cast upon him by your article does him a gross injustice. . . . The members of the Eastern Stockholders' Committee are prominent business and professional men of unimpeachable integrity. Their sole object was to assist . . . in the securing of subscriptions to a contingent fund for its mill and other equipment and the operation of same. . . . These subscriptions have now practically all been paid and the money is in the treasury of the company to use in paying cash for all equipments, freight, labor and all other expenses incurred." Despite our intervention, and despite the interest of the Michigan authorities, success has evidently crowned the efforts of the professor of English in his excursion into the mining industry, to "enhance the value of his own investments" and "for the good of all concerned."

The "unimpeachable integrity" of any non-engineering member of the faculty of a university and that of his non-technical associates—to all of whom the technique of mining development is a closed book—has no bearing whatsoever on the ethical question as to whether or no their statements and opinions shall be used for raising funds for the provision of a mill on a mining property. And we trust that the majority of mining engineers will actively support *Engineering and Mining Journal* in helping to secure a nation-wide acceptance of the underlying principles of ethics and economics involved.

New California Income Tax Bill Is a Disappointment

THE Nelson bill now under consideration by the California Legislature proposes a 4 per cent tax on the net proceeds of mines as well as upon other business in that state. The draft of the bill in our hands proposes to allow as a deduction from gross income, in addition to other obvious allowances, "exhaustion, wear and tear, and obsolescence of property used in the business," on the basis provided in sections 113 and 114 of the U. S. Revenue Act of 1928. Mines are allowed depletion on the basis of the 1926 provision of the Federal Revenue Act.

The bill seems to be loosely drawn, and will evidently be the subject of much legal controversy if it passes in its present form. The depletion provision for mines is based on valuation, and will therefore entail great difficulty in its application. An absurd provision is embodied, stating that "in the case of mines discovered by the taxpayer after Feb. 28, 1913, the basis for depletion shall be the fair market valuation of the property at the date of discovery or within 30 days thereafter."

As this tax bill is to be amended during the present recess of the legislature, further comment would be out of place. It is worthy of note, however, that the prospects of the California metal miner for equitable taxation are not promising. Instead, he is apparently to pay more taxes, and the county levies will remain unchanged. As an example, a Mother Lode property that was sold under the hammer for $48,000 was assessed $226,000 by the county when in the hands of its new owners. Remedies for such conditions were hoped for from state legislation. The amendment so guilelessly passed by the voters last November has brought forth a proposed state income tax that leaves much to be desired.

No Ore for Chief Con.'s Volatilization Process

RECENT news from Utah indicates that Chief Consolidated is to abandon its oxide volatilization process. The valiant efforts of this company, and particularly those of its competent metallurgist, Mr. George H. Wigton, to solve the treatment problem of the refractory Tintic ores are deserving of commendation; the cessation of work is the result of a failure in ore supply and not to lack of metallurgical skill.

Optimism has been the basis of the success achieved by several operators in the Tintic district. The irregular occurrence of the limestone-replacement deposits, the prevalence of faulting, and other adverse factors—these might have proved too discouraging to combat. About twenty years ago the Chief Consolidated organization had its inception in the optimistic and aggressive development of the original Little Chief property by its founder, Mr. Walter Fitch. A few years later the Tintic Standard venture of Mr. E. J. Raddatz was successful when ore was found more than 1,000 feet below the barren andesite-covered hills east of the Chief Consolidated's principal holdings. In this background of successful optimism apparently lies the explanation of an expensive metallurgical venture on the part of Chief Consolidated, undertaken virtually without proved ore reserves.

The work of Mr. Wigton in successfully developing the volatilization process constitutes one of the most interesting chapters in recent non-ferrous metallurgical research. Pilot-plant operation of the process—which involves the volatilization of the gold, silver, and lead, without the addition of chemical reagents, and their subsequent recovery in the form of baghouse fume—yielded such excellent results for several months on the stubborn Tintic ores that its commercial success seemed assured. However, with the erection of the large plant, ore similar to that treated in the pilot plant was not forthcoming inadequate amount.

So highly specialized a process obviously could not be extremely flexible in operation. Nevertheless, each new problem introduced by changes in the character of the ore was attacked and solved with rare technical skill. The difficulty in removing kiln accretions resulting from the treatment of easily fusible material was overcome by the development of a water-cooled steel plow. A novel pulverized-coal burner avoided excessive slagging in the flues. The selective dropping of zinc from the fume was partly perfected. These and numerous other problems equally complex were overcome in the face of disheartening odds.

The effort has been an expensive one, and criticism has been directed at Chief Consolidated for continuing the work when it was known that no adequate reserves of suitable ore existed. Such criticism may or may not be justified, depending on the individual viewpoint. However, if the criticism is a just one in this instance, it might also be applied to the work that resulted in the discovery and development of the two biggest properties in the Tintic district. Perhaps it is not fair to say that the Wigton volatilization process failed, inasmuch as it was not applied to the type of ore for which it was originally developed. Friends of Chief Consolidated, as well as metallurgists interested in progressive technical development, will hope that ore may yet be found for which the process is adapted, so that successful commercial application will be reached.

RESEARCH . . . *Aids in*

Successful continuation of work on the production of ferromanganese from Lake Superior ores justifies encouragement and protection of manganese mining enterprise in the United States

General view of experimental blast furnace at the North Central Station, Minneapolis

FOR several years the U. S. Bureau of Mines has been conducting at its North Central Experiment Station a co-operative investigation with the Minnesota School of Mines Experiment Station, to determine the feasibility of obtaining from manganiferous iron ores a product suitable for use in the production of ferromanganese. The size, state of development, ease of mining, and proximity of the Minnesota iron-ore deposits to the Great Lakes make their utilization of outstanding importance.

Two types of manganiferous iron ore which occur in Minnesota have been described in previous reports.[4] Of the two types the so-called brown ores are best adapted for pyrometallurgical treatment to recover the manganese. These ores are essentially iron ores containing from 5 to 10 per cent of manganese; therefore the utilization of their iron content in the production of steel must furnish the basis of their treatment. The problem consists essentially in modifying the production of steel from such ores so as to recover the manganese as a byproduct and in a form suitable for use in manufacturing ferromanganese.

Although sufficient progress has been made to show that it is feasible to produce from manganiferous iron ores, containing from 5 to 10 per cent manganese, a product from which ferromanganese can be manufactured, there are a number of problems which require further experimentation. The present discussion of the problem must therefore be regarded as a progress report, giving the results thus far obtained and outlining the problems which will receive further study.

Casual inspection of Table I will show the development that has taken place in the use of manganiferous

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[4]Joseph, T. L., and Kinney, S. P.: "Minnesota Manganiferous Iron Ore in Relation to the Iron and Steel Industry"; Bull. 12, University of Minnesota School of Mines Experiment Station, Feb. 10, 1927; Joseph, T. L., Barrett, E. P., and Wood, C. E.: "Minnesota Manganiferous Iron Ores in Relation to the Iron and Steel Industry"; *Trans.* A.I.M.E., 1927, Vol. 75, pp. 292-338.

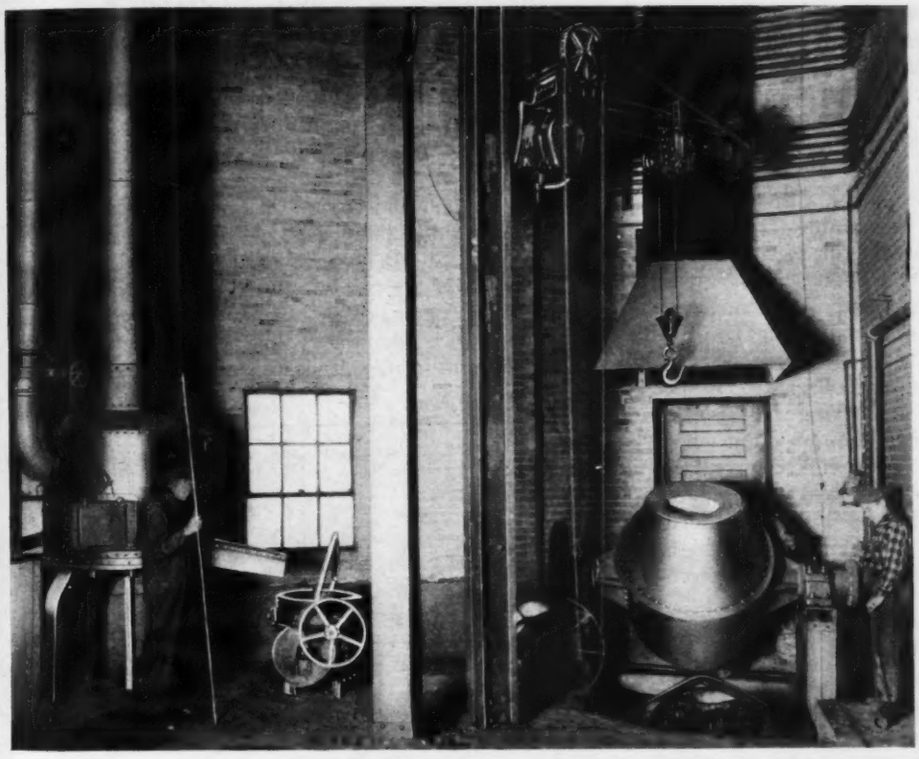
Fostering a Domestic Mining Industry

By T. L. Joseph[1], E. P. Barrett[2] and C. E. Wood[3]
Minneapolis, Minn.

iron ores (over 2 per cent manganese). The annual tonnage of these ores, supplied from the Lake Superior district, increased more than tenfold during the period 1911 to 1927, although the increase in annual steel production over the same period was less than twofold. Large quantities of manganese are furnished the iron and steel industry in the form of manganiferous ores. For example, in 1926, 156,821 tons of metallic manganese was supplied as manganiferous iron ore—almost half the tonnage of manganese used in that year as ferro and spiegel (330,178 tons). Manganiferous ores are benefiting the industry under present practice, as pointed out in a previous report,[5] but a glance at the columns of figures in Table I giving the tons of manganese derived from manganiferous ore and the pounds of manganese per ton of steel over the same period shows very clearly that the large quantities of manganese supplied in the form of manganiferous iron ore have not appreciably affected our needs for ferro and spiegel. The obvious explanation is that only a fraction of the manganese supplied as manganiferous iron ore reaches the steel ingot.

Under present practice, sufficient manganiferous iron ore is added to the ore mixture of a basic blast furnace to

[5]See foot note 4.



Cupola and side-blown experimental converter used in manganese investigation

Two-hundred-pound experimental open-hearth furnace

Table I—Manganese From Low-Grade Ores and Manganese From Ferro and Spiegel

Year	Manganiferous Ore, Tons (a)	Manganese, Average per Cent	Manganese, Tons	Steel, Gross Tons	Total Manganese, Ferro and Spiegel, Tons (b)	Manganese, Pounds per Ton of Steel
1911	450,127	3.25	14,629	23,676,106	148,889	14.1
1912	827,154	3.02	24,980	31,251,303	197,541	14.2
1913	882,144	3.21	28,317	31,300,874	217,658	15.5
1914	622,290	3.63	22,589	23,513,030	162,112	15.4
1915	881,020	3.33	29,338	32,151,036	174,247	12.2
1916	1,794,325	4.34	77,874	42,773,680	282,150	14.8
1917	1,621,305	6.18	100,197	45,060,607	278,271	13.9
1918	2,613,135	6.61	172,728	44,462,432	286,453	14.5
1919	1,732,300	4.35	75,355	34,671,232	179,942	11.6
1920	2,377,560	5.23	124,346	42,132,934	263,286	14.0
1921	230,726	4.71	10,867	19,783,797	104,441	11.8
1922	1,592,266	5.88	93,625	35,602,926	214,497	13.5
1923	2,441,586	6.36	155,285	44,943,696	303,643	15.1
1924	1,438,241	7.00	100,677	37,931,939	254,195	15.0
1925	2,247,472	6.57	147,659	45,393,524	285,558	14.1
1926	2,296,065	6.83	156,821	48,293,763	330,178	15.3
1927	2,402,442	6.40	153,756	44,935,185	286,929	14.3

(a) Lake Superior Iron Ore Association authority for manganiferous ore tonnages and grades.
"(b) Mineral Resources of the United States," now compiled by U. S. Bureau of Mines, authority for tonnages of steel, ferro, and spiegel.

produce pig iron containing from 1.5 to 2 per cent manganese. When this high-manganese pig iron is charged into the basic open-hearth furnace with about equal or slightly greater amounts of steel scrap, most of the manganese passes into the slag, which will contain from 5 to 10 per cent MnO. In the proposed practice to recover manganese in a form suitable for making ferro, manganiferous iron ores are not mixed with straight iron ore, but make up the entire ore charge. In this procedure, high phosphorus spiegel containing from 10 to 15 per cent manganese is produced in place of basic pig iron with 1.5 to 2.0 per cent manganese. By giving this spiegel a preliminary treatment, the manganese can be concentrated so that a slag containing from 40 to 50 per cent manganese will be produced in place of normal open-hearth slag containing from 5 to 10 per cent manganese. The basic idea underlying the proposed practice is to concentrate the manganese to a point where a product suitable for making ferro will be produced. In present practice the manganese is diluted with lime, silica, and alumina, and contaminated with phosphorus to such an extent as to limit its use in making high-manganese pig iron and prohibit its use for making ferro-manganese or spiegel.

Blast-Furnace Tests

Although Minnesota manganiferous iron ores had been used with other ores, the brown ores had not been used alone. It was not definitely known, therefore, whether a charge of 100 per cent brown ore could be smelted without difficulty. To test the behavior of such an ore charge and to provide metal for small-scale open-hearth and converter tests, the experimental blast furnace, shown in one of the illustrations, was developed. About 150 tons of metal containing approximately 12 per cent Mn, 4.5 per cent C, 0.25 per cent Si, and 0.55 per cent P was produced during a six weeks' campaign of the experimental furnace. A detailed report on this operation and a complete description of the furnace have been published.[6]

In the first part of the bessemer blow, oxidation of silicon and manganese predominates. The composition of the slag depends upon the relative amounts of manganese and silicon in the metal to be blown and the extent of lining corrosion. This may be illustrated by the analyses of two pig irons and of the corresponding converter slags, given in Table II.

In the basic process, phosphorus is eliminated during the so-called "after-blow." The possibilities of securing a high-manganese, low-phosphorus slag during the first part of a bessemer blow seemed to warrant investigation. Although manganese would be eliminated more slowly in the basic converter than in an acid converter, corrosion of the lining would be less and the basic oxides thus picked up by the slag would be much less objectionable than silica from an acid lining.

The side-blown, basic-lined converter, shown on page 309, was designed and erected to determine the kind of slag which could be obtained by blowing metal containing about 10 per cent Mn and 0.5 per cent P. In general, the slags obtained were too high in iron and phosphorus to be suitable for making ferro. The manganese and silica content were satisfactory, but because of high phosphorus and high-iron content the slags would have to receive further treatment before being used to make ferromanganese. Loss of manganese by oxidation and dusting, together with difficulty in controlling the blow and the ejection of large amounts of slag from the converter, makes this method of recovering manganese from high-phosphorus spiegel less feasible than the method of treating it in an open-hearth furnace.

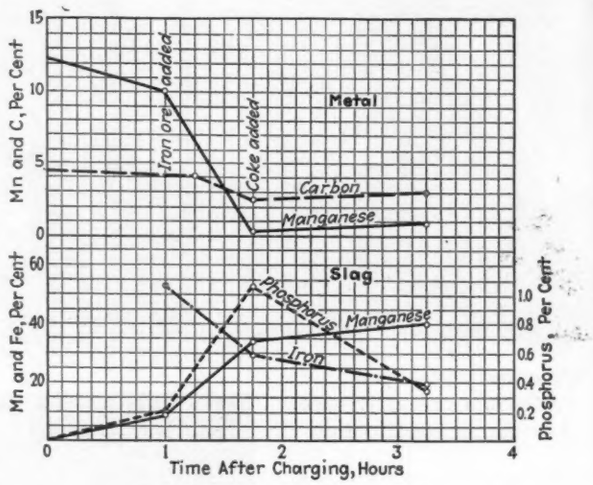


Fig. 1—Log of heat No. 208

Table II—Analyses of Pig Iron and Corresponding Converter Slags

Pig Iron[7] Constituents, Per Cent				Converter Slag Constituents, Per Cent					
C	Si	Mn	P	SiO_2	MnO	FeO	Al_2O_3	CaO	MgO
3.93	2.39	0.49	0.09	64.15	12.81	13.95	5.71	0.75	0.24
4.22	1.06	5.12	....	37.63	48.92	9.45	2.94	1.00	0.46

[6] Joseph, T. L., and Kinney, S. P.: "Minnesota Manganiferous Iron Ore in Relation to the Iron and Steel Industry": Bull. 12, University of Minnesota School of Mines Experiment Station, Feb. 10, 1927.

[7] Stoughton, Bradley: "Metallurgy of Iron and Steel." McGraw-Hill Book Company, 1923, p. 106.

The ratio of manganese to iron in the slag was found to depend upon the manganese left in the metal. As the manganese in the metal decreased during the course of a blow, the iron in the slag increased. The amounts of phosphorus and iron, however, were found to be prohibitive, even though 3.5 per cent manganese was left in the metal. Results were not as satisfactory as those obtained in preliminary open-hearth tests. Therefore most of the investigation has been devoted to studying the possibilities of open-hearth treatment for getting a slag containing 40 to 50 per cent Mn, about 5 per cent Fe, under 0.2 per cent P, and 10 per cent SiO_2, and small amounts of Al_2O_3, CaO, and MgO.

Open-Hearth Tests

One of the first difficulties encountered in treating high-phosphorus spiegel in the experimental open-hearth (see page 309) was corrosion of the lining. In the first tests an attempt was made to prevent oxidation of the

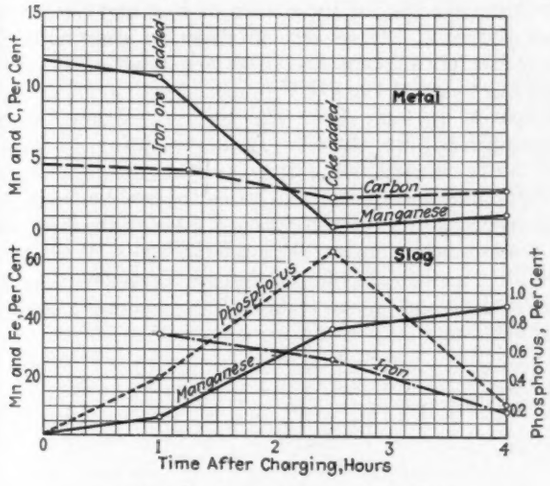


Fig. 2—Log of heat No. 229

phosphorus from the metal and subsequent contamination of the slag. Several months were spent in trying to find a combination of acid lining and water-cooled blocks which would minimize corrosion and produce a slag containing under 0.2 per cent of phosphorus. During this time it became evident that to eliminate the manganese in the metal to below 1 per cent, the FeO in the slag would have to equal about one-third of the MnO in the slag; in other words, if the manganese in the slag was 48 per cent, the iron would be about 16 per cent. Such a ratio of manganese to iron is much too low for material intended for use in making ferromanganese. The phosphorus content of the slag was also prohibitive. By leaving 3 or 4 per cent of manganese in the metal, slags of suitable composition could be obtained, but this result was not desirable, because the object of the whole procedure was to recover as much manganese oxide as possible in material which could be charged into a blast furnace to produce ferro. The necessity of adjusting the phosphorus and iron in the slag became obvious.

Experiments were made to determine whether the iron and phosphorus could be reduced from the slag with a comparatively small reduction of manganese. It was found by spreading a layer of coke over the slag that the iron and phosphorus could be reduced at a rate depending to a great extent upon the fluidity of the slag.

With a method available for adjusting the phosphorus

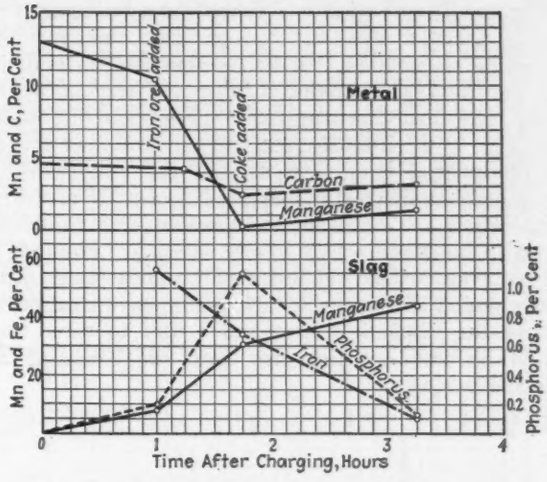


Fig. 3—Log of heat No. 205

and iron in the slag, a series of heats was made with a chrome lining, followed by another set of tests with a magnesite lining. To oxidize the manganese in less than six or seven hours it was necessary to increase the fluidity of the slag by adding silica. This difficulty has been overcome by maintaining the iron content of the slag between 30 and 35 per cent, rather than between 15 and 20 per cent.

Figs. 1 to 4, inclusive, show the logs of several heats and illustrate the method of working the heats and the more important changes which take place in the slag and metal. In active practice the hot spiegel would be charged directly from the blast furnace into an open-hearth furnace. It was not feasible to operate the experimental blast furnace and the open hearth simultaneously. Therefore it was necessary to melt the spiegel in the experimental open hearth. One hundred pounds has been found to be a convenient charge. This quantity of cold spiegel is melted and preheated to about 1,500 deg. C. one hour after charging.

The heat may be divided into two periods, an oxidizing period and a reducing period. During the oxidizing period, manganese, silicon, and about one-half of the carbon are eliminated. By using enough iron ore to maintain about 30 per cent Fe in the slag at the end of the oxidizing period, the manganese in the metal can be reduced to about one-half of 1 per cent in an hour. By the time the manganese has been reduced to this point,

Table III—Analyses of Slags Made by Blowing Metal Containing About 10 per Cent Mn and 0.5 per Cent P

Test No.	Mn	Fe	P	SiO_2	MgO	CaO
7	38.88	19.53	0.91	11.96	....	0.3
8	56.26	17.84	0.29	4.40	....	1.23
9	48.82	8.67	0.37	9.92	....	3.84
10	41.94	15.14	0.46	8.83	....	1.70
11	39.18	20.00	0.80	7.80	2.23	0.40
12	36.20	19.93	1.28	8.50	0.39	1.60

the manganese oxide in the slag has increased to a slightly greater amount than the iron oxide. The phosphorus in the slag at the end of the oxidizing period is normally about 1 per cent. During the oxidizing period, iron oxide in the slag is replaced by manganese oxide as follows:

$$FeO + Mn = MnO + Fe$$

Metallic iron thus formed is taken up by the metal.

The oxidizing period is followed by a reducing period during which a layer of coke or other reducing agent covers the slag. Figs. 1 to 4 show that the oxides of iron and phosphorus are reduced from the slag at a much faster rate than the manganese. For example, in heat 198 (Fig. 4) the iron dropped from 28 to 7.4 per cent and the phosphorus from 0.98 to 0.22 per cent, while the manganese in the metal increased from 0.5 to 1.0 per cent. Table IV shows the composition of the final slag. From an hour and a half to two hours are required for the reducing period. If hot metal from a blast furnace were charged into a furnace for preliminary treatment to remove the manganese, two and a half to three hours should be sufficient time for both the oxidizing and reducing periods.

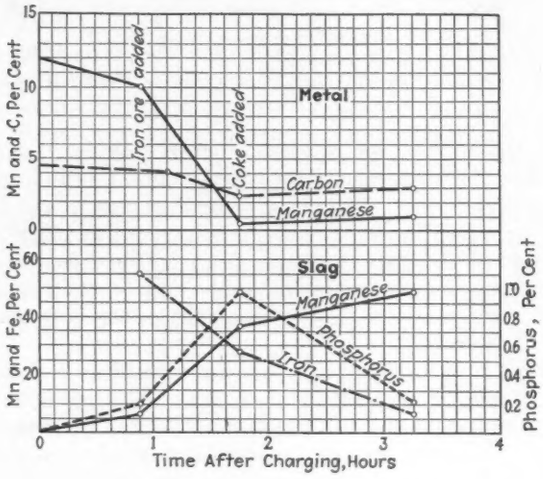


Fig. 4—Log of heat No. 198

The iron and phosphorus contents of the slags appear to be very definitely related, as shown by Fig. 5. If the iron content of the slag is about 5 per cent, the phosphorus content is generally satisfactory. Proper adjustment of iron and phosphorus seems to be possible but requires a longer time for low-silica slags. To produce such slags would require the use of low-silica iron ore or roll scale as oxidizing agents and low-ash coke or petroleum coke as reducing agents. More tests will be necessary to establish the conditions for producing slags of varying silica content.

By maintaining high iron content during the oxidizing period, the slags can be kept in a fluid condition. The concentration of FeO in the slag has both a direct and indirect effect upon the rate of oxidation of manganese. Higher concentrations of FeO create a larger driving force for the reaction

$$FeO + Mn = MnO + Fe.$$

Table IV—Composition of Some Final Slags Made in the Small Experimental Open-Hearth Furnace

Run No.	Mn, per Cent	Fe, per Cent	P, per Cent	SiO_2, per Cent
90	49.2	4.5	0.26	....
94	44.5	3.6	0.17	....
101	50.5	9.6	0.19	11.4
117	49.0	4.8	0.08	....
118	42.9	3.2	0.20	....
121	45.3	7.1	0.25	....
194	46.0	17.0	0.38	6.4
197	44.1	11.7	0.22	9.4
198	48.9	7.4	0.22	11.2
205	44.0	4.7	0.10	14.7
207	48.2	7.6	0.13	11.4
209	44.9	12.6	0.65	10.0
216	46.4	10.4	0.28	11.8
223	47.7	8.6	0.64	12.6
229	44.5	8.6	0.22	13.8

Inasmuch as MnO melts at about 1,600 deg. C. and FeO between 1,350 and 1,400 deg. C., the latter oxide makes the slag more fluid—a condition favoring rapid diffusion and rapid reaction rates.

The oxidizing period in heat 229 (Fig. 2) required a longer time than in the other three heats. Red hematite, containing about 60 per cent Fe, was used in heats 198, 205, and 208, and manganiferous iron ore containing about 35 per cent Fe and 8 per cent Mn was added to heat 229. Owing to the lower iron content and a more viscous slag, the oxidizing period was about one-half hour longer in heat 229.

The greatest difficulty was to obtain a slag low in silica and at the same time to reduce rapidly the oxides of iron and phosphorus in the slag to within the allowable limits in material used in producing ferromanganese. At the time the coke is added the slag is very fluid, but as the FeO is reduced the slag begins to stiffen to a degree depending upon the amount of silica present. Heats 194 and 197 (Table IV) show the effect of low-silica content upon the reduction of the oxides of iron and phosphorus from the slag. Heat 205 produced a slag higher in silica; the phosphorus and iron are lower than in the low-silica heats 194 and 197.

Experiments have been made in a stationary furnace, necessarily bottom tapped. A larger tilting furnace is now under construction. It was necessary to add silica to the stationary furnace in order to tap the final slag. Improper draining of the furnace after individual heats has made material balances unsatisfactory. With a larger tilting furnace it is hoped that more viscous slags can be handled and more satisfactory material balances obtained.

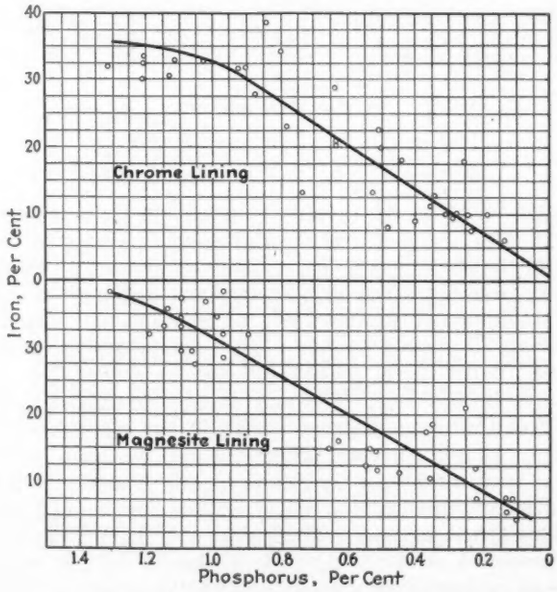


Fig. 5—Effect of iron on the phosphorus content of high-manganese slags

Small-scale tests under carefully controlled conditions showed no loss of manganese at temperatures from 1,575 to 1,625 deg. C. in a reducing atmosphere. A loss of manganese did take place under an oxidizing slag. Results indicate that much of the so-called volatilization of manganese probably takes place by oxidation followed by dusting.

In discussing the reserves of Lake Superior manganiferous iron ores, Zapffe[8] states:

We may set down the Cuyuna district as possessing a reasonably safe reserve of 44,000,000 tons. Barrett[9] lists the reasonably assured reserve of manganiferous iron ore from the Marquette, Gogebic, and Menominee iron ranges as 7,913,075 tons averaging 3.66 per cent Mn, 1,580,912 tons averaging 6.37 per cent Mn, and 1,670,941 tons averaging 12.5 per cent Mn. Large deposits of manganiferous iron ore are known to exist in Grant County, New Mexico, and in other localities. Modifications in blast-furnace practice and in open-hearth practice to recover a slag suitable for producing ferromanganese could be made in a relatively short time, because the changes would be modifications of a well-established procedure and would involve only minor changes in equipment. A safeguard to national security will be provided by establishing the modifications in practice which are necessary to make the manganese in our large reserves of manganiferous iron ore readily available for producing ferromanganese.

[8]Zapffe, Carl: "Reserves of Lake Superior Manganiferous Iron Ore." *Trans.* A.I.M.E., Vol. 75, 1927, p. 365.
[9]Barrett, L. P.: Discussion of paper, reference 8.

Applying Flotation to Treatment of Low-Grade Bauxite Ores

ABOUT 85 per cent of the world's production of bauxite is being used as a source of aluminum and aluminum chemicals, so the mineral may properly be termed an ore, says the U. S. Bureau of Mines in a bulletin recently released.[1] Of the two fields in the United States that produce bauxite, the Arkansas field supplies over 90 per cent of the present production, and the Appalachian field the remainder, which comes from the states of Alabama, Georgia, and Tennessee. The Appalachian field has considerable quantities of low-grade bauxite not as yet commercially available for lack of a suitable method of concentration. The Bureau of Mines has recently, therefore, been experimenting on the concentration of these ores, especially with reference to the removal of silica and iron. Titanium is usually present as well, but not in sufficient quantities to cause trouble.

The following minerals are the main constituents of the bauxite found in the Appalachian field: Gibbsite, which is the valuable mineral, and the following gangue minerals: kaolinite, hematite, and limonite. Some samples also showed small quantities of quartz sand and siderite, and titanium was present in all samples in quantities varying from 1½ to 4.9 per cent of titanium oxide.

Grinding to 100 Mesh Not Sufficient for Commercial Treatment of Some Ores

Crushed samples were fractionated by treatment with heavy liquids of a specific gravity such that the gibbsite would float and the silica-bearing kaolinite, and the iron minerals, would sink. Such fractionations on sized products showed that, with some samples, grinding even to 100 mesh was not sufficient to free the interlocked gibbsite and kaolinite sufficiently for commercial concentration. With others, 20 or 28 mesh was sufficient. The iron minerals were usually less disseminated than the kaolinite, satisfactory separations being made in many instances on 4- or 8-mesh material.

The iron minerals may be removed by gravity separation, as there is a marked difference in specific gravity. Kaolinite and quartz, however, have substantially the same specific gravity as gibbsite, so that some other method must be used for their removal, such as froth flotation. A 50-gram laboratory flotation machine was used in the preliminary experimental work which was followed by tests with a 500-gram machine. In the trial of various reagents, distillation products of wood and coal gave only negative results. Tests were finally made using sodium sulphide and oleic acid as reagents, and it was found that these made the gibbsite floatable without affecting the kaolinite or free silica. Conditioning was necessary, however, the pulp requiring violent stirring and agitation with sodium sulphide for at least ten minutes before the addition of the oleic acid. The addition of kerosene, or machine oil, with the oleic acid facilitated the flotation of the gibbsite.

Grinding was done to 65 mesh, and the ratio of water to ore during the conditioning period was 1½ to 1. The shaft speeds of the experimental 500-gram machine were found to be important, 500 r.p.m. being about right during conditioning, 975 during the initial run, and 700 r.p.m. during the middling re-run, in which the concentrate from the last part of the initial run was re-treated.

Removal of Fine Material From Feed Improves Separation

Separation of mineral and gangue was very inefficient until the 270-mesh material was removed from the feed, whereupon fair results were secured, a concentrate being obtained which assayed 10.6 per cent less silica than the feed, and represented 60 per cent of the feed by weight. On samples high in iron, the gibbsite concentrate was found to be higher in iron than the feed, though the concentration of the iron with the gibbsite was not particularly noticeable.

Silica content of bauxite to be reduced to metallic aluminum by the Bayer process should not be over 5 per cent, but when used for the manufacture of aluminum chemicals as much as 15 per cent is allowable. Low-grade bauxite ores may be brought down to 15 per cent silica or less by flotation concentration, but a purity as low as 5 per cent does not appear to be feasible by this method.

Large ore reserves would be necessary to justify the building of a commercial flotation plant, and these are not generally available in the Appalachian field. About 5 or 6 lb. of sodium sulphide per ton would likely be required in commercial operations, involving a cost for this reagent of about 18c. per ton of ore treated. The flotation process would seem to have its most promising field in enriching border-line ores, bringing them within the limit of specifications.

[1]"Preliminary Examinations of Low-Grade Bauxite, With Particular Reference to Flotation," By B. W. Gandrud and F. D. DeVaney.

Discussing a Metallurgical Failure

The Importance of Knowing What to Avoid in Designing a Small Mill

By F. Le Roi Thurmond
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MANY small milling plants in the Western mining states contain a heterogeneous assortment of equipment that is worn out, more or less obsolete, that is not ordinated, or is unadapted to the work it is expected to perform. Results under such circumstances are unsatisfactory, and the mill is a failure, or must be revamped. Costs in the end are greater than they would have been had proper equipment and design been employed.

I was recently associated with an enterprise owning a 50-ton mill designed and sold by an engineering firm. This plant contained such glaring errors of design and arrangement that expensive delays resulted and certain defective parts had to be removed and proper equipment substituted. Errors in this instance were not chargeable to rigid economy, inasmuch as they were integral with design and factory fabricated. The plant cost about $50,000, which is close to engineering estimates for plants of this kind and capacity. Errors made in building this mill are discussed in this paper.

The mill was designed to concentrate a complex sulphide ore by selective flotation, and to make three products: a lead-silver concentrate, a gold-iron concentrate, and a zinc concentrate, containing a minimum of precious metals. Equipment, as furnished by the designers, consisted of a ball mill, a classifier, a small high-speed jaw crusher for secondary crushing, eight flotation cells of novel design, one sand pump, one belt ore-feeder, one ore elevator, and two centrifugal blowers to furnish air to the flotation cells. A circular steel ore bin was also included in the design and furnished by the engineering company. To this equipment it was necessary to add three sand pumps, one conditioning tank, one dry reagent feeder, one thickener, one drum-type filter and accessory equipment for dewatering the gold-iron concentrate, and four settling tanks for dewatering the lead and the zinc concentrates.

The mill was built on a slope. A glance at the illustration, which shows the arrangement of the grinding section, reveals the axis of the ball mill to be at right angles to the slope of the mill site. The ball-mill pinion shaft, which is also a line shaft, was placed by the designers on the down side of the ball mill, and the motor on the upper side. This arrangement would have caused the drive belt to pass by the classifier discharge with only a few inches of clearance from the classifier overflow launder, besides preventing ready access of the operators to ball mill and classifier discharges, and subjecting the belt to the slop from the classifier overflow. The motor was therefore placed on the down side of the ball mill. Direction of revolution of the ball mill was clockwise (facing the discharge end), which threw the belt slack on the lower side if the belt were run straight. The belt was 12 in. wide, six ply, and 18 ft. between pulley centers. Under these conditions a crossed belt would have been unsatisfactory, and consequently the belt was run straight. A fixed idler had to be placed under the belt to keep it tight on the pulleys, the accumulated slack being taken up by an adjustable motor base. Another defect due to the arrangement of the pinion shaft was in the countershaft driving the blower. This was placed near the floor close to the classifier, where slop from that machine would cause the belts to slip off, and prevent approach to the ball-mill discharge on the floor level. A runway had to be constructed over belts and pulleys that made them difficult of access and dangerous to operators.

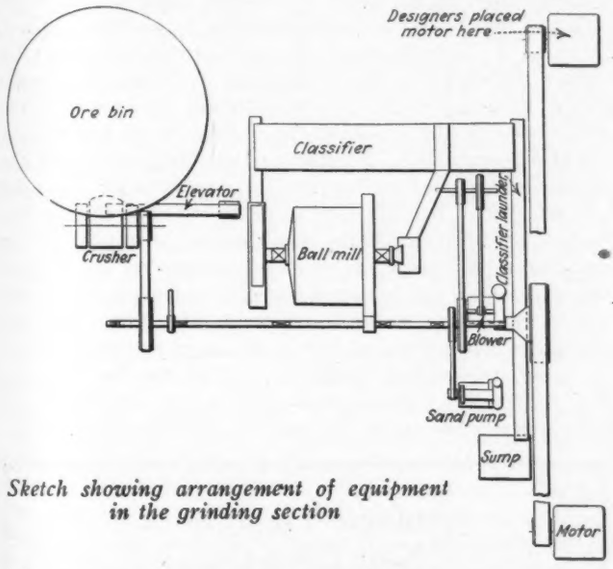
Apparatus was crowded adjacent to the ball-mill discharge. The clutch pulley on the pinion shaft, clutch, belts, blower, sand pump, launder, sump box, and countershaft all were crowded together near the discharge end of the ball mill, making access for greasing, repairs, and general operating purposes extremely difficult and dangerous. No room was available for the clutch lever when in the usual horizontal position, so a platform was constructed over the pinion shaft and the lever placed in a vertical position. Every millman is familiar with the trouble that occurs when launders are too flat. The classifier overflow launder in this installation was given a slope of 8 in. in 17 ft., or slightly less than one-half inch per foot. This slope was changed to one inch per foot, which is the minimum that launders carrying this class of material should have. The sump box was placed at such an elevation that it had insufficient head over the sand pump. Pumps furnished by the engineering company had no suction, and the manufacturers recommended that there be at least a 3-ft. intake head above the pump shaft for normal capacity.

Probably the most palpable error in arrangement was in placing the secondary crusher between the mill ore bin and the scoop feed-box of the ball mill. This was arranged to take the ore from the belt feeder and deliver it to the bucket-elevator boot, which in turn delivered it to the scoop-feed box. With this arrangement the crusher had to run whenever the mill was operating; a hang-up at the crusher cut off the feed to the ball mill and threw the whole train of operations out of balance. Moreover, in handling wet, sticky ores the crusher clogged frequently. As a further refinement on this arrangement, the crusher, which was of the roll jaw type, was set to run backwards!

Another defect contingent upon misplacing the crusher was the entailed necessity for an elevator to deliver the ore to the scoop feed-box. As constructed, this elevator consisted of a steel frame supporting head and

tail pulleys, and a belt carrying buckets and driven from the head end. The angle of slope was 43 deg. from the vertical, and the feed from the crusher was delivered to the elevator in such a way that pieces of rock would fall between the lower and approaching side of the belt and the tail pulley, causing the elevator to stop and the drive belt to slip off. Owing to the angle of slope and the conditions of the structure, nothing could be done to keep the rock from stopping the belt, so the elevator was removed and a bucket elevator on a sprocket chain substituted. The erroneous arrangement of crusher, feeder, and elevator was clearly recognizable in the design before erection was begun, but the material was on the ground, fabricated of steel by the designers in their shops, and no further alteration was possible without a complete redesign and scrapping of the costly material on hand.

The flotation machines were of the pneumatic type, with no mechanical moving parts. Air for flotation was furnished by centrifugal blowers and delivered to the



Sketch showing arrangement of equipment in the grinding section

machines from a manifold directly over the cells. From the manifold, 2-in. down-pipes spaced 12 in. apart delivered the air near the bottom of a central agitation chamber, giving a pachuca effect and agitating and aërating the pulp to such an extent as to cause it to overflow into spitzes on each side of the cell. The froth overflowed the spitzes into launders, and the tailing was discharged at the lower end of the cell. Tailing discharge was controlled by sand and weir gates. A small item apparently, but one of much significance in operation, was the fact that these gates, being of iron and sliding in wooden slots, would bind, and could be adjusted only with a pinch bar or lever, giving much annoyance to the operators, and making for inefficient operation. In one plant which I visited recently, where similar machines were in use, the sliding gates had been discarded and adjustable weirs built up of square mouldings were laid between guides, with an iron bar of the same dimensions laid on top to keep the weir from floating.

Centrifugal blowers furnished were supposed to deliver air to the flotation machines at from 9 to 10 oz. per square inch, and two blowers with 25-in. fans, rated at 2,500 ft. of free air per minute, were provided to agitate the pulp in 70 lineal feet of the flotation cells. No. 1 blower was connected to three cells having a combined lineal footage of 30 ft. The blower was run at 2,845 r.p.m., the maximum speed recommended by the manufacturer, but it failed completely to agitate the pulp in the three cells. By cutting off one 14-ft. cell and speeding the blower up to 3,000 r.p.m., satisfactory operation of the remaining 16 ft. of flotation cell length resulted. No. 2 blower, as designed, was connected to 40 lineal feet of flotation cells, and it was changed to agitate 26 ft. Although this blower was the same size as No. 1, it had a 12-in. instead of a 10-in. outlet, and hence less resistance and greater efficiency. The air piping system was rearranged, and designed to meet the requirements of low resistance, by eliminating short bends, thus adding somewhat to the blower capacity.

There was still 28 ft. of flotation cell length to be agitated by a third blower. One of the 25-in. fans furnished by the designers was connected to these machines and numerous trials were made. The result in each instance was failure. The air piping was redesigned, with an attendant gain in the amount of air delivered to the machines, which was still insufficient. On the advice of the designers the manifold was redesigned, the number of down-pipes into the pulp was doubled, and their diameter was reduced from 2 to 1¼ in. This resulted in a further improvement, but the machines still packed. The blower was then speeded from 2,845 to 3,080 r.p.m., and after 48 hours of operation the blower shaft failed. A larger and heavier blower having a capacity of 5,000 cu.ft. of air per minute at 2,200 r.p.m. was then installed. This solved the problem of agitating the pulp in the flotation machines, but at a cost exorbitant in contrast to the saving they were supposed to effect. The imminent possibility of burned-out bearings with the high-speed blowers was always present; an unnecessary multiplicity of machines had to be watched; and a rush of coarse sand, or a high pulp level, could still clog the cells. The manufacturers of this type of flotation cell have admitted the failure of centrifugal blowers with their equipment, and have substituted positive blowers in subsequent installations—small consolation, however, for the mining company which pays the bill.

Tailings from the lead rougher unit flowed through a short launder to the zinc rougher unit. Zinc was depressed by the addition of sodium cyanide and zinc sulphate in the ball mill, and it was necessary to re-activate the zinc, by the addition of copper sulphate. In practice, insufficient conditioning time was allowed for this to take place. Pulp from the lead rougher was then dropped to the sand pump, which returned the middlings from the zinc cleaners to the head of the zinc circuit. Improved results were immediately apparent at the head of the zinc rougher.

In the pyrite flotation section there was no opportunity for conditioning with sodium sulphide after the pulp from the zinc rougher was passed through launders, sump boxes, and the sand pump. It was necessary to install a conditioning tank ahead of the sand pump, where a ten-minute conditioning period secured satisfactory pyrite recovery. Adequate means for the control of the addition of flotation reagents at required points in the circuit is seldom provided by the designers of small mills. I was present at the starting up of one 150-ton selective flotation plant where, up to the very day that operations were to be started, absolutely no provision was made for feeding reagents other than two small oil-feeders.

Some designers recommend the feeding of copper sulphate, soda ash, and other water-soluble reagents from a stock tank or barrel containing the solid salt and through which a controlled volume of water is conducted that gives a saturated solution at all times. This is unsatisfactory, because of the tendency of saturated solutions to crystallize in pipes or other conductors when there is a slight lowering of temperature or evaporation of water. Greater difficulty is also experienced in regulating the quantity of reagent added in a concentrated solution than there is in adding dilute solutions. In 50-ton operation it becomes impossible to reduce the quantity of reagents to the small amounts required unless they are in dilute solution.

I have found 5 to 10 per cent solutions of copper sulphate, cyanide, and the xanthates easily controlled and regulated in pipe or hose lines equipped with hard rubber pet cocks. Another advantage of using dilute solutions is that slight variations due to carelessness of operators will cause less circuit disturbance. In this particular installation I designed a reagent system for the water-soluble reagents that consisted of five rectangular tanks 4 ft. wide, 8 ft. long, and 4 ft. high. Each tank was divided by a partition into two equal compartments, and each compartment held approximately one ton of solution. While the solution in one compartment was being used, solution for the other compartment was being prepared, and the opening and closing of a valve made the change from one to the other. These tanks were on a platform above the ball mill, and pipe connections to the various points in the flotation circuit were provided.

My experience with settling boxes to dewater concentrates was unsatisfactory in this instance. Settling tanks used were 8 ft. square and 4 ft. high, and were provided with filter bottoms. Two-inch drain pipes led to a moisture trap, from which the water was carried off by a barometric leg. Vacuum from the 8½x9-in. filter vacuum pump was applied through a 2-in. line at the top of the moisture trap. A vacuum of 18 to 20 in. of mercury would not pull the water from more than a 1-in. bed of the slimy lead concentrate on the bottom. A high-moisture concentrate and high labor costs in frequent cleaning of the settling boxes resulted. Zinc concentrate was more granular and filtered readily, so that the water could be drawn from the settling boxes with 6 to 12 in. of concentrate on the bottom. At best, settling boxes are costly and an ill advised expedient. I calculated that in this instance, with the production of three tons of concentrate per day, the extra labor cost and charge for the excess moisture would pay for the installation of a thickener and filter in one year's time.

Magnesite Has Many Uses

MAGNESITE has manifold uses and plays a part in the daily life of everyone. Known to science as magnesium carbonate, it is produced in the United States mainly in California and Washington. The uses to which this mineral has been or may be put are summed up as follows in a report recently published by the U. S. Bureau of Mines:

For refractory brick, shapes, crucibles, and furnace hearths, for which both death-burned magnesite and dead-burned dolomite are used; for medicinal and toilet preparations, which are made from magnesite, dolomite, and natural magnesium sulphate; for pipe covering (mixed with asbestos), which in this country is made from dolomite; for oxychloride (Sorel) cement, which is made from a mixture of caustic calcined magnesite and magnesium chloride; as an absorbent in the manufacture of dynamite, fused magnesia for insulation at exceedingly high temperatures, and an adulterant of paint—all of which presumably call for calcined magnesite but are relatively unimportant in the consumption of domestic magnesite; in the manufacture of carbon dioxide and the sulphite process of paper manufacturing, in both of which magnesite has been largely displaced by the cheaper dolomite or limestone; and for metallic magnesium, which is made from magnesium chloride.

Millstone Production Is Declining

AMERICAN millstones have been and are still for the most part made of quartz sandstone and conglomerate, chiefly in Ulster County, N. Y., and Montgomery County, Va., but also in Pennsylvania, according to a recent report of the U. S. Bureau of Mines. Millstones are also made of granite, particularly in Alabama, Maine, Minnesota, New Hampshire and North Carolina. Formerly the millstone manufacturing industry was much larger than at present. About 1880 the total value of the stones produced and sold in the United States was around $200,000 annually. Production has declined since the late 'eighties, and during the last seven years has been valued at less than $50,000 annually. The decline is due in part to the fact that the manufacture of millstones is a handicraft in which, as in many others in the United States, the old master craftsmen, who are gradually disappearing, are not being replaced. In part, also, the change is attributable to new processes in the grain, paint, and mineral milling industries in which the old-style burrstones and chaser mills are being supplanted by grinding equipment of an entirely different type.

Geologic Thought in New Directions

THE mining industry is beginning to realize the value of the microscope as an appropriate tool for use in research and control. The petrographic microscope has not received the attention it deserves, and the results that might well be expected if it were used more extensively have not been adequately appreciated. Many engineers see no novelty in considering the factor of rock alteration as a guide to ore. The contiguity of altered rock and ore is well known, but advantage has not been taken to apply this knowledge in practical work. The literature of mining geology fails to include reference to the interpretation of rock-alteration phenomena in practical terms. But it is interesting to note that more attention is being paid, in instructional work, to the relation between rock alteration and ore finding. For a considerable time Mr. Norman Smith, whose academic training was received at the Massachusetts Institute of Technology, at the University of Giessen, and at Harvard, and who has served in a geologic capacity on the staffs of Chief Consolidated, Tintic Standard, and International Smelting, has devoted much thought to the subject. A suggestive and informative article by him, on the application of the petrographic microscope to the geologic problems related to the search for ore, will appear in a forthcoming issue.

Ore Genesis and Oreshoots

By CARLTON D. HULIN
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Part I of this paper, published in the issue of Feb. 9, dealt with the subject of ore genesis. Part II is essentially a synopsis of "Structural Control of Ore Deposition" to appear in "Economic Geology," now in press.

Veins and Oreshoots

ONE of the most impressive features in the occurrence of primary metallic ores is that they are sporadic and exceptional. Our mining camps may be permeated with quartz veins and yet be economically dependent on only one oreshoot or, at most, a few oreshoots. Quartz veins are abundant in nature; oreshoots are not. Can we believe that the same solutions which deposited the silica and other gangue minerals in such a widespread manner would concentrate the metallic minerals in such limited occurrences? Or, rather, is it not more reasonable to believe that the solutions which deposited barren veins over such wide areas were followed by a second set of related solutions which deposited the metallic minerals locally where openings still existed for their passage?

Present-day theories of ore genesis have failed miserably to furnish a satisfactory explanation for the localization of oreshoots. Many of the theories of oreshoot control which have been advanced appear plausible when applied to strictly local conditions, but none possess the virtue of general applicability. Yet oreshoots of similar types are known to possess the same characteristics throughout the world, and hence must manifestly have been controlled by the same fundamental factors.

The theory of ore genesis advanced in this paper provides a concrete explanation for the occurrence of both oreshoots and barren veins. Barren veins are formed during the early stages of mineralization, being deposited in existing fissures by the silica-bearing solutions. Oreshoots are produced during the latter part of the period of mineralization wherever openings still exist through which the metallizing solutions may pass and deposit their load.

In general, the early siliceous solutions will fill completely all existing fissures with barren quartz veins. These veins will remain barren unless subsequently reopened by intermineralization faulting—faulting contemporaneous with the mineralization. The nature and magnitude of the reopenings which may occur will manifestly be controlled by local details of the vein structure.

FAULTING IN MINERALIZED REGIONS

The importance of pre-mineral and intermineral faulting in mining regions has been vastly underestimated. It has been my experience to observe that faulting, beginning in pre-mineral time, usually reaches a maximum of activity by the early part or by the middle of the period of mineralization, after which it declines, commonly, however, outlasting the period of mineralization. Pre-mineral faulting is important in that at this time the vein fissures are formed as are most of the faults. Intermineralization faulting is important in so far as fault movements during this time continually modify the effects of the mineralization. Post-mineral faulting is important only to the extent that it may cause displacements of the veins or orebodies.

Where segments of a vein or orebody are displaced the displacements are ordinarily interpreted as being post-mineral. My experience, however, has led me to believe that post-mineral displacements of consequence are uncommon, most *apparent* displacements of veins or orebodies actually representing pre-mineral or intermineral offsets of the vein fissure. In such formations the cross-faults show definite evidence of the effects of the mineralization. These effects may be pronounced, or they may be slight, depending on the abundance of gouge in the cross-fault. Gouge, apparently, is largely immune to the effects of mineralization. The products of mineralization which have been deposited along cross-faults have in many instances been brecciated by later fault movements thereon, with the result that such material has commonly been classed as "drag ore." This would seem to be a somewhat mythical substance.

THE MECHANICS OF VEIN FORMATION

Current theories to account for the mode of formation of veins are practically limited to the following:

1. By filling of an open fissure.
2. By replacement.
3. By the force of crystallization of the vein minerals.
4. By the hydrostatic pressure of the vein-depositing solutions.
5. By injection of a viscous ore magma.

The true mode of origin of many veins has apparently been overlooked—namely, the repeated reopening of the vein fissure by fault movements acting contemporaneously with the mineralization, and the repeated filling of the small openings so produced. To designate this mode of formation the term *vein formation by accretion* has been proposed. Our knowledge of the behavior of faults gained from the Elastic Rebound Theory is to the effect that the displacements now apparent along faults have resulted from repeated movements of small magnitude which are separated by periods of fault quiescence. The process of vein formation by *accretion* calls for nothing more than those small recurrent movements which are postulated by the Elastic Rebound Theory, accompanied by more or less continuous mineralization. By this process veins of any thickness could be developed without openings of other than trivial size ever having existed.

There is abundant evidence, both in the field and in the microscopic study of ores, that reopenings and brecciation have occurred abundantly in vein ores, both dur-

ing the period of deposition of the early barren quartz and during the time of the late metallization. Detailed evidence to substantiate this statement cannot be presented here. Suffice to say that definite evidence of intermineralization brecciation has been found to be commonplace in ores from many of the important mining camps of North America as well as from many deposits in other parts of the world.

The question as to why the intermineralization fault

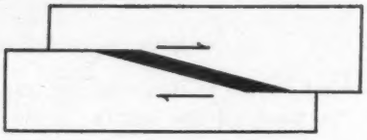


Fig. 5—Favorable structure produced by variation in strike of the vein fissure

movements are not relieved in the wall rocks, rather than in the previously deposited vein matter, naturally presents itself. To some extent they probably are, but in the wall rocks, already hydrothermally altered and softened, the movements will result in the development of gouge-filled slips and fissures which will be relatively tight and impervious. In contrast, the brittle vein quartz, when stressed, will be brecciated to form a porous mass quite permeable to the later mineralizing solutions.

Formation of Oreshoots

The process of accretion which is recognized as being operative during the formation of veins is equally important in the development of oreshoots. The locus of ore deposition will in general be repeatedly brecciated and reopened during the time of activity of the metallizing solutions, the openings so produced being concurrently filled by the deposition of ore minerals.

If the siliceous solutions and the metallizing solutions appear at about the same time, they will mix and deposit their loads contemporaneously, in which event the oreshoots, if such be developed, will be "shoots of occurrence" —that is, the oreshoots will be more or less coextensive with the vein filling. Usually, however, the metallizing solutions do not appear until late in the period of mineralization. In general, then, the oreshoots will not be coextensive with the vein filling, but will be limited to those portions of the vein which are subject to brecciation and reopening during the later stages of the mineralization.

Openings for the passage of the metallizing solutions and for the deposition of ore being available, oreshoots will result provided the physical-chemical conditions are

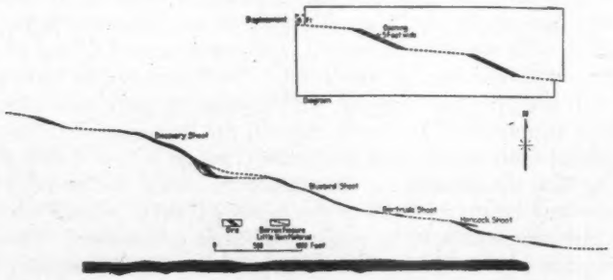


Fig. 6—Oreshoots controlled by variation in strike of the vein fissure. Camp Bird vein, Colorado. After Spurr.

favorable for deposition. The deposition of ores from solution, following the Zonal Theory, is a function of decreasing temperature, pressure, and concentration. Decreasing temperature tends to lower the saturation points of the materials carried by the solutions, with consequent deposition. Likewise, decreasing pressure may have a direct effect upon deposition. Of perhaps greater import, however, is the possibility that decreasing pressure may permit the escape from solution of dissolved mineralizers, which in turn may radically affect the solubilities of the dissolved mineral substances.

In short, the deposition of ore is dependent upon favorable physical-chemical conditions of temperature, pressure, and concentration, whereas the control of the locus of deposition is mechanical, being dependent on favorable local structure of such nature that, when acted upon by intermineralization fault movements, at the proper time, during the sequence of mineralization, brecciation and reopening will result.

Manifestly, all favorable structural positions along a vein may not be brecciated by intermineralization fault movements at the proper time—that is, just preceding or during the time of the metallization. In consequence, all favorable positions will not necessarily be the hosts of oreshoots.

There would appear to be no way of predicting, in advance of actual exploration, whether a structurally favorable position in a vein had or had not been affected by fault movements at the proper time during the mineralization. Commonly, however, in advance of actual

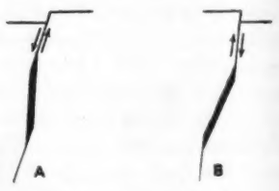


Fig. 7— Favorable structure produced by variation in dip of the vein fissure. A, Normal fault. B, Reverse fault.

exploration, a prediction as to what portions of a vein are likely to be structurally favorable is possible. Knowing that oreshoots, if such occur, will be localized in these positions, it becomes clearly a matter of vital importance to recognize and classify the various types of structures which may be favorable for the development of oreshoots.

Structures Favorable for the Formation of Oreshoots

The following types of structure I have recognized as being favorable for oreshoot localization. With the exception of cases 7 and 8, actual examples of each type have been encountered and studied in detail.

1. Variation in Strike of Vein—Horizontal shear acting along a vein fissure will produce brecciation and reopenings in any portion of the vein where local variation in strike exists. (Fig. 5). Such positions of local variation in strike therefore must be classed as being favorable for the development of oreshoots. In base-metal oreshoots controlled by this type of structure, the variation in strike is usually pronounced. In precious-metal oreshoots, however, the variation in strike may amount to only a few degrees and hence be scarcely perceptible. In many instances of both base- and precious-metal oreshoots that I have studied, it has been possible to demonstrate that ore deposition was localized in structures of this type. Perhaps the clearest example of oreshoots controlled by variation in strike of the vein fissure which has been recorded in the literature is that of the Camp Bird vein described by Spurr[2]. (Fig. 6).

[2]J. E. Spurr: "The Camp Bird Compound Veindike." *Economic Geology*, Vol. 20, pp. 115-152, 1925.

2. Variation in Dip.—Variation in dip of a vein produces structures which may favorably affect oreshoot localization. The mechanics of this control are similar to those of variation in vein strike. Two cases must be recognized. Where the vein fissure has undergone normal displacement, the steep portions of the vein are the more favorable (Fig. 7*A*); whereas if the displacements have been of a reverse nature the flatter portions of the vein will be the more favorable (Fig. 7*B*).

3. Intersection of Vein and Cross-Faults—The positions of many oreshoots have been controlled by cross-faults. Intermineralization movements occurring along a cross-fault may result in brecciation and reopenings of adjacent portions of the vein. The oreshoot, localized by these reopenings, may be confined to the immediate vicinity of the intersection, or may extend for some distance along the vein, being terminated at the cross-fault. In some cases the vein fissure has remained tight on one side of the fault, but has been "stretched" open on the other side, resulting in the development of a large orebody (Fig. 8). Within my own experience oreshoots controlled by cross-faults are very abundant. The cross-faults may be planes of pronounced movement, or they may be rather minor joint planes, but in any case they must have undergone intermineralization displacements.

4. Vein Intersections—Vein intersections are similar in their reactions to the intersections of a vein and cross-faults. Any vein intersection is a position of weakness and is subject to brecciation as the result of movements acting along either vein. Such a position is then at least twice as favorable as any other random position along either vein. Vein intersections do not always contain oreshoots, but many oreshoots are so localized.

5. Simple Shear Along Vein—In precious-metal veins it is commonplace to find the major part of the mineralization confined to a thin layer in the vein, the rest of the vein being comparatively barren. The control of such rich streaks of vein matter is to be found in the minor

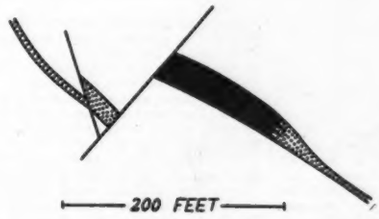


Fig. 8—Oreshoot (black) controlled by cross-fault of intermineralization age. From actual mapping, Sunnyside mine, Colorado.

reopenings and brecciation which are produced by simple shearing movements acting along the vein, unaccompanied by any pronounced favorable structure. Reopenings produced by simple shear unaccompanied by favorable structure are rarely if ever of sufficient magnitude to permit of the formation of base-metal oreshoots, though narrow streaks rich in sulphides commonly result from this type of control.

6. Torsion Structures—Shearing stress acting in the crust of the earth may be relieved by shear along fissures striking parallel to the direction of stress, or such stresses may be relieved by the development of torsion fractures striking diagonal to the direction of stress. Such torsion fractures will tend to gap open, and, if formed at the proper time, will constitute favorable sites for ore deposition. The most perfect example of oreshoot control by this type of structure which I have known is found in the vein system of the California Rand Silver mine. (Fig. 10). Here the initial fissures, striking parallel to the stress, were sealed by the early barren siliceous stage of the mineralization. Later stress movements, finding the initial fissures tightly sealed, were relieved by the development of diagonal torsion fractures. These torsion fractures, coming into existence late in the period of mineralization, received the bulk of deposition from the metallizing solutions, resulting in the formation of rich oreshoots. The veins filling the initial fissures are productive only where they were shattered by the intermineralization fault movements.

7. Bedded Veins and Saddle Reefs—Where a series of bedded strata are undergoing folding, arching of the

Fig. 9—Oreshoot (black) controlled by vein intersection. From actual mapping, Sunnyside mine, Colorado.

more competent beds tends to produce openings below the competent beds in the anticlines and above the competent beds in the synclines. Shear likewise tends to occur between competent members on the flanks of the folds, and rupture may affect the beds at the crests of the folds. These openings which *tend* to occur are normally filled as rapidly as they form by internal deformation of the less competent beds. If, however, the region of folding is being mineralized, these incipient openings which tend to form may be filled by the products of mineralization. Thus saddle reefs, trough reefs, or leg reefs may be produced. (Fig. 11). The respective locus of formation of each of these bodies is likewise definitely a locus for repeated brecciation and reopenings —the result of the folding. Clearly, therefore, these several types of reefs may well be formed by accretion. Replacement may be active, but it is not essential to the development of saddle reefs.

The oreshoots of these several types of reefs are ordinarily not coextensive with the reef, but constitute only a small portion thereof. Published descriptions of these shoots indicate that usually they are connected with structures along which intermineralization displacements have probably occurred. Commonly, the oreshoots occur

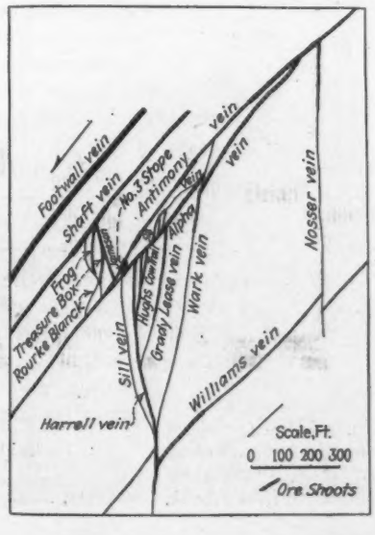


Fig. 10—Plan of vein apexes, California Rand Silver mine, Randsburg, Calif. The veins of the northeast system antedate those of the north-south system.

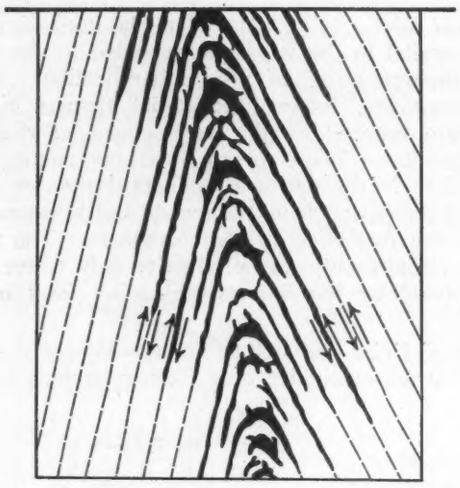


Fig. 11 — Auriferous quartz saddle reefs in sharply folded slates. Slightly modified after Faribault. The arrows are the author's.

where the reefs are crossed by fault lines; in other cases the ore follows the intersection of a reef with shale layers or other beds which may well mark the planes of bedding faults consequent on the folding. Known evidence in connection with saddle reefs and bedded veins therefore is to the effect that the oreshoots have been formed by accretion, the loci of ore deposition being also the loci of brecciation and reopenings during the late stage of metallization.

8. Structures of Mineral Subsidence—Locke has recently described[3] certain orebodies in which the locus of ore deposition has been controlled by the brecciation and faulting resulting from the subsidence of a block of rock. Ordinarily the brecciated area takes the form of a pipe or of an annular fault zone. (Fig. 12). Subsidence of the central pipe of rock in part precedes the mineralization, but to some extent continues through the time of mineralization—to the extent at least that the sulphides are dependent for their emplacement on the openings which are existent during the time of the late metallization. Examples of orebodies controlled by structures of this type include those of the Pilares mine, Sonora, Mexico and several at Bisbee.

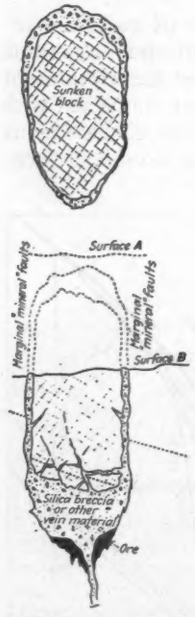


Fig. 12 — Oreshoot control by structure produced by mineral collapse. After Locke.

The foregoing classification includes the several types of structure favorable for oreshoot development so far identified. Though it is believed that the more important and more common types have been recognized, that all possible types of structure favorable for oreshoot development are as yet known does not necessarily follow. That none of the favorable structures listed are actually favorable unless acted upon by intermineralization fault movements immediately preceding and during metallization must be emphasized in any case.

[3] A. Locke: "Formation of Certain Ore Bodies by Mineralization Stoping." *Economic Geology*, Vol. 21, pp. 431-453, Aug., 1926.

States' Rank in Mineral Production

PENNSYLVANIA, with its great coal production, continued to rank as the leading mineral-producing state in 1927, according to statistics just made public by the U. S. Bureau of Mines. In addition to coal, output of cement, clay products, and natural gas also contributed considerably to the state's total mineral production, valued at $937,123,000. Petroleum and natural gas are credited mainly for the ranking of the western states of Oklahoma, California, and Texas, in second, third and fourth places, respectively. Following these are the eastern states of West Virginia, Ohio, Illinois, and Kentucky, where coal also is the chief item in mineral production, except that in Ohio clay products outranked coal. Michigan, Kansas, New York, Indiana, Minnesota, and Arizona each produced more than $100,000,000 worth of minerals in 1927. Every state is included in the list of mineral producers. A detailed tabulation follows:

Mineral Production of the Different States, 1927

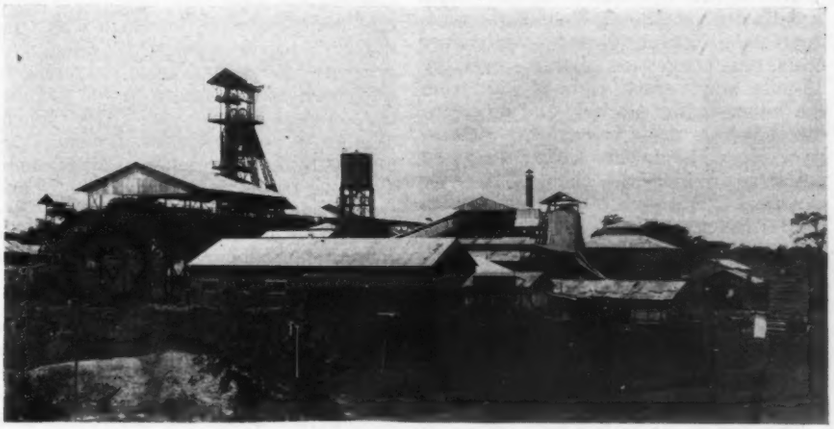
State or Territory	Principal Mineral Products	Amount
Pennsylvania	Coal, cement, clay products, natural gas	$937,123,000
Oklahoma	Petroleum, natural gas, zinc	524,595,000
California	Petroleum, natural gas, cement	459,638,000
Texas	Petroleum, natural gas, sulphur	374,503,000
West Virginia	Coal, natural gas, petroleum, clay products	366,643,000
Ohio	Clay products, coal, natural gas, stone	226,731,000
Illinois	Coal, clay products, petroleum, cement	180,288,000
Kentucky	Coal, petroleum, clay products, natural gas	152,614,000
Michigan	Iron ore, copper, cement, sand and gravel	124,030,000
Kansas	Petroleum, zinc, natural gas, cement	120,369,000
New York	Clay products, stone, cement, gypsum	111,580,000
Indiana	Coal, stone, cement, clay products	107,578,000
Minnesota	Iron ore, stone, cement, clay products	102,973,000
Arizona	Coal, gold, silver, lead	100,559,000
Utah	Copper, lead, coal, silver	90,368,000
Alabama	Coal, iron ore, cement, clay products	78,641,000
Missouri	Lead, clay products, cement, coal	75,890,000
New Jersey	Clay products, zinc, cement, stone	73,058,000
Montana	Copper, zinc, petroleum, coal	67,833,000
Arkansas	Petroleum, coal, natural gas	59,449,000
Colorado	Coal, gold, zinc, lead	58,855,000
Wyoming	Petroleum, coal, natural gas	56,167,000
Louisiana	Petroleum, natural gas, salt	51,267,000
Virginia	Coal, cement, clay products, stone	41,320,000
Tennessee	Coal, cement, stone, clay products	37,875,000
Iowa	Coal, cement, gypsum, clay products	33,426,000
Idaho	Lead, silver, zinc, stone	29,184,000
New Mexico	Copper, coal, zinc, petroleum	28,609,000
Nevada	Copper, gold, silver, gypsum	26,753,000
Washington	Coal, cement, clay products, sand and gravel	21,966,000
Wisconsin	Stone, zinc, sand and gravel, iron ore	21,777,000
Maryland	Coal, clay products, cement, sand and gravel	20,469,000
Florida	Phosphate rock, stone, fuller's earth, sand and gravel	18,096,000
Georgia	Stone, clay products, cement, fuller's earth	16,756,000
Massachusetts	Stone, clay products, sand and gravel, lime	16,295,000
Vermont	Stone, slate, lime, talc	14,703,000
Alaska	Copper, gold, coal, silver	14,402,000
North Carolina	Stone, clay products, sand and gravel, copper	11,652,000
South Dakota	Gold, cement, stone, sand and gravel	8,455,000
Connecticut	Stone, clay products, lime, sand and gravel	7,299,000
Oregon	Cement, stone, sand and gravel, clay products	6,821,000
Maine	Stone, lime, clay products, slate	5,476,000
South Carolina	Stone, clay products, sand and gravel, barite	4,251,000
Nebraska	Sand and gravel, cement, clay products, stone	3,542,000
New Hampshire	Stone, clay products, sand and gravel, feldspar	3,447,000
North Dakota	Coal, sand and gravel, clay products	2,870,000
Mississippi	Sand and gravel, clay products, natural gas, stone	2,554,000
District of Columbia	Sand and gravel, clay products, sand-lime brick, stone	1,375,000
Rhode Island	Stone, sand and gravel, clay products, lime	1,311,000
Delaware	Clay products, stone, sand and gravel	493,000
Total		$4,901,929,000

Errata

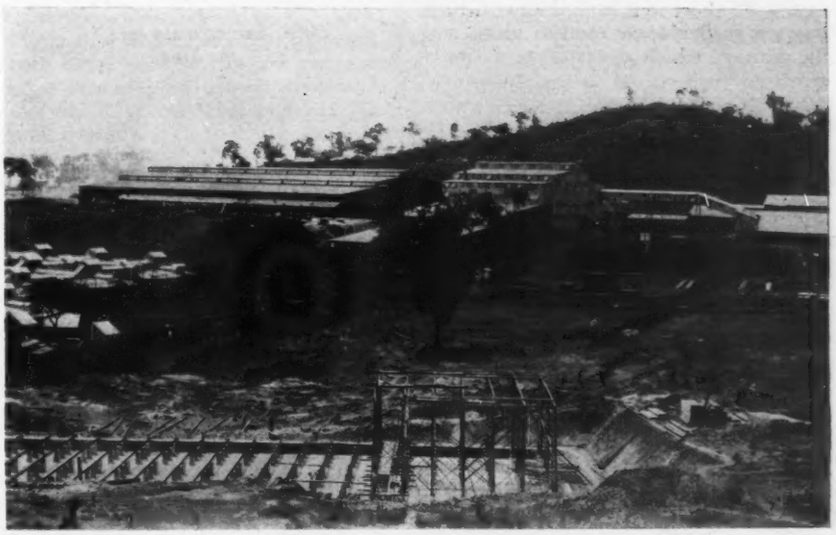
In reference to Mr. George L. Walker's interview in London of Mr. A. G. McGregor in the Feb. 16 issue, on "Important Canadian and African Developments": we have received cable advice that an error was made in designating the apparatus for catching the dust in the roaster and converter gases. Cottrell collectors will be used for this purpose. In the article on "Making a 30-ton California Gold Mine Pay," by Mr. George J. Young, published in the Jan. 12 issue, the power requirement of the plant of the Original Mine, in Mariposa County, Calif., is given as about 4 kw.-hr. per ton milled. The figure should have read "40 kw.-hr."

AT LUBUMBASHI, which is the metallurgical center of the eastern group of the Union Minière properties. The company employs at present about 14,000 natives, but to bring the mines up to full strength a total of 18,000 is required.

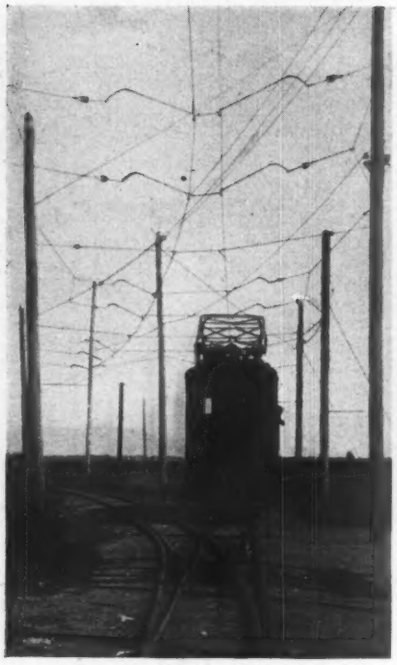
In the Belgian Congo Copper Region



THE SURFACE PLANT at the Prince Leopold mine, a high-grade property in the southeastern part of the concession which supplies the Lubumbashi smelter, but only one of 180 known deposits of copper ore within the boundaries of the concession. Comparatively few of these are now being exploited.



CONSTRUCTION of the leaching plant at Panda, shown in the foreground of the picture at the right, is proceeding rapidly. It will have an output of 36,000 tons a year and will bring the Union Minière potential producing capacity up to 150,000 tons. In the background are the 5,000-ton concentrator and the smelter, which serve the central group of Union Minière mines.



One of El Potosi's electric locomotives

More Tonnage at Lower E

is Result of

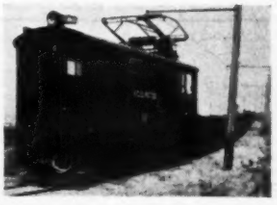
Electrifying Mine Railroad

By H. A. WALKER
Superintendent, Santa Eulalia, Chihuahua, Mexico

EL POTOSI Mining Company's 30-in. gage steam railroad for many years served its mines in the Santa Eulalia district near Chihuahua, Mexico. Increasing operating and maintenance costs, plus congestion of traffic over the 15-mile single-track right-of-way from the mines to the smelter, and other indirect factors made betterments imperative. In consequence, during 1925 the entire main line was changed over to electrical operation, a 600-volt d.-c. overhead trolley system being installed. This is the only industrial narrow-gage electric railway in Mexico, the only other installation of any type in the country being that of Mexican Railways, Ltd., which has 70.23 miles of broad-gage road electrified in southern Mexico.

The equipment includes five General Electric locomotives weighing approximately 25 short tons each, four of which operate as double or tandem units, and the fifth of which operates as a single unit. In addition, there is a 13-ton G.E. switching unit equipped with a 200-hp. motor. The large double units comprise two 25-ton locomotives, each with 400 hp., giving 800 hp. per train, and work on a schedule of approximately one hour's running time each way from the mine to the smelter. Although regenerative braking was taken into consideration in the design of the locomotives, the power returned to the line is of minor importance, braking being used principally to give greater safety in handling the trains down heavy grades and around many short-radius curves. Regenerative braking in turn makes for operating economy in less breakage of wheels and axles.

Design of the locomotives follows main railroad practice, employing four motors, one on each axle, double swivel trucks, fully inclosed box cabs, and regenerative braking. A motor generator is used to furnish excitation to the motors when acting as generators, with connections for series and parallel braking making possible braking speeds from 8 to 20 miles per hour.



THE manifold advantages in modernizing methods, and proof that equipment functioning satisfactorily may be classed as hopelessly obsolete—these are some of the "high spots" of this article. Note the improvement effected in net economic results by the substitution of electric in place of steam traction.

An ore train on the bins

Sub-stations are located at the mine, San Guillermo mill (5 miles from the mine), and at San Alberto (2 miles from the smelter). Each sub-station is equipped with a 500-kw. synchronous motor-generator which furnishes the power required in either direction over the line.

Pantograph trolleys are made of sec-

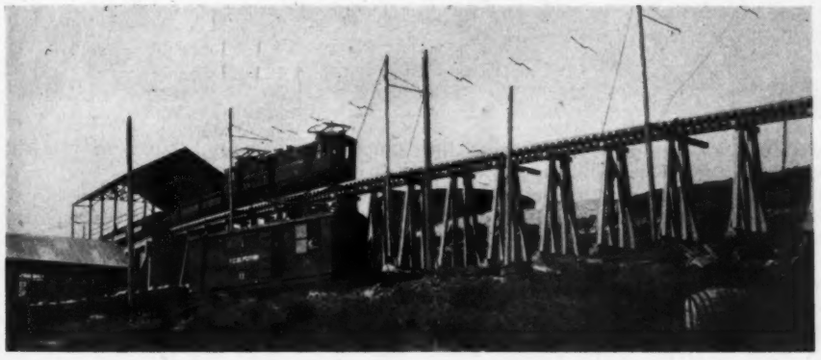
Expense

The double unit handles heavier train loads than could the old steam equipment

tional steel tubing (similar to bicycle tubing) in the company shops, and have proved much more practical than the cast aluminum type, which caused much delay when there was any breakage in service.

Major benefits resulting from the electrification of El Potosi company's railroad are as follows:

1. A marked increased in train loads, with corresponding decrease in cost of manning trains.



The track gage is only 30 in.

2. Ability to move considerably more tonnage in 24 hours than was possible formerly.

3. Ability to handle normal high tonnages under electrical operation, which, with the greater congestion resulting from the use of steam trains, would have been impossible.

4. Decreased cost of maintenance of equipment, and fewer accidents and derailments from broken wheels and axles, this reducing the losses in running time considerably.

Under steam operation a crew of five — namely, engineer, fireman, and three brakemen—handled a train of eight to sixteen cars carrying 50 to 120 short tons of ore down grade to the smelter. A crew of the same size now mans a double unit transporting 200 tons of ore.

Under steam operation five to seven train crews were necessary to handle a monthly production of 20,000 to 25,000 short tons. At present three double-unit shifts, one single-unit shift, and the small switching unit move approximately 57,000 short tons of ore, freight, and concentrates per month.

During the last year of steam operation traffic became so heavy over the single-track line that considerable delay was experienced through the side-tracking of trains while they awaited other units coming from the opposite end of the line. Large quantities of coal were moved to coaling points, trains stopped to take on water and fuel, and considerable boiler trouble was experienced because of poor water.

Cost of maintenance of equipment is much lower because of lesser mechanical forces required for upkeep, repairs, and overhaul of units. Under steam operation it was difficult to operate a unit more than one shift per day, following which it went into the roundhouse for servicing. No trouble whatever has been experienced in operating electrical units two shifts whenever necessary. Through regenerative braking, individual strains on car axles and wheels have been minimized and running time losses from this source are rare, whereas it was a common source of trouble under steam operation. Accidents were numerous with steam trains, but are now negligible. In addition, the train crews take great pride in the equipment and exercise much greater care in lubricating it properly and keeping it clean than was their custom with the steam units previously in use.

The data given for 1924 in the accompanying table were entirely for steam operation. In 1925 operations were carried on with steam until Sept. 1, with the exception of a steam-switching unit at the mine. In 1926, they became entirely electrified, with the substitution of the new thirteen-ton electric switch engine for the steam unit in September. The data for 1928 represent the first ten months only, during which time 572,428 short tons was transported with a power consumption of 1,312,250 kw.-hr. and at an average cost of 2.13c. per ton-mile for 4,932,223 ton-miles. The power cost is reasonable for Mexico but considerably higher than obtained in the Pacific northwest.

The marked economies noted in the tabulation are to be credited partly to the greater tonnages handled, but the fact must again be emphasized that neither the steam equipment nor the right-of-way would have been adequate to service the present normal tonnage demands. As it is, there yet remains considerable leeway for further traffic increases by the simple expedient of adding a few more railroad cars and running one of the units an additional shift.

Comparative Operating Data

	1924	1925	1926	1927	1928
	Steam	8 Months, Steam; 4 Months Electric	Electric	Electric	Electric
Cost per short ton of ore or freight moved	0.777	0.445	0.320	0.213	0.202
Cost per ton-mile of ore or freight moved	0.0466	0.0404	0.0314	0.0228	0.0213
Short tons moved	178,580	228,741	436,806	581,873	572,428

The High Cost of Mining in Nayarit

To the Editor of "E.&M.J.":

Reading occasional dispatches from Mexico, I wonder why the truth is so seldom told and how many know the real situation as it exists today along the west coast, especially south of Tepic.

The man doing business in Mexico in the large cities is safe, but the lone mine manager, in an isolated place, sometimes without any protection whatever and always employing a semi-hostile people, is in an entirely different position. Regardless of obstacles and danger, he is expected to carry on operations efficiently and show profit on capital invested. He must not antagonize the rebels but at the same time must stand in well with the government. He must account to the government for all explosives purchased, but upon demand he dare not refuse the rebels what they ask. If this becomes known, his supply is cut off and he may be accused of aiding the rebellion—a serious charge.

For the benefit of those contemplating mining operations in the State of Nayarit, my last experience may be of interest.

Last fall I was engaged to erect a flotation mill and operate a silver mine in Nayarit, about 70 miles south of Tepic, and was advised to proceed to Guadalajara, where full information and funds awaited me. Were I not of an optimistic nature, my reception in Guadalajara would certainly have been depressing, for I found neither funds nor data of any description. I was informed by those in a position to know that the section in which the mine was located was infested by rebels, who completely controlled the territory, that such a thing as operating the mine was out of the question, and that the best thing for me to do was to get on the train and go home.

However, as I did not take the 1,500-mile trip down for pleasure, I decided to continue to my destination and, funds having finally arrived, I proceeded to the mine, arriving there without meeting the much dreaded rebels. Nayarit has spots that are unsurpassed for natural beauty and wealth of vegetation and the mine was located in such a spot.

My first move was to send out word that I desired to meet the rebel leader. I had not long to wait, for on the second day I was honored by a visit from Lorenzo Arriola, then in supreme command of the rebel forces in Nayarit. Arriola proved to be an exceptional Mexican, and a man of reason and intelligence. The result of our conference was that he not only promised not to molest me but also gave me a pass for safe travel through the rebel lines to go and come at my pleasure. In fairness to him I must say that never did he molest me or my men, keeping his word in every particular.

Fortified with this understanding, I began operations and continued without interruption until Arriola was deposed from command and succeeded by Guadalupe Flores. The latter proved to be an entirely different individual—a small, dark Indian type who wanted money, plenty of it, and right away. Nothing else would satisfy him. After a second raid it became necessary to pay him $20,000 in Mexican gold or take the consequences. Said consequences having been explained to me in detail, the money was paid and I departed for a climate perhaps not quite so pleasant but certainly much safer.

Of course, during the period of my operations, I had to stand off repeated raids of minor bandits or rebels, but this in brief was my experience, and having come in personal contact with every rebel of consequence in Nayarit, I can freely say that the American mine manager in this state will certainly earn his salary, which, at best, is poor compensation for the risk involved.

Keene, Calif. E. J. BUMSTED.

[Mr. Bumsted's letter is of interest, as a brief record of one man's experiences in one part of Mexico. Banditry still exists in certain regions, but it is only fair to state that general conditions in the mining industry throughout the republic are becoming more and more stabilized.—EDITOR.]

Bowl Classifiers in Modern Milling Practice

To the Editor of "E.&M.J.":

I have read with interest Mr. Anthony Anable's article in the Industrial Progress section of the *E.&M.J.* of Dec. 22, 1928, entitled "Some Recent Metallurgical Developments." On page 991 Mr. Anable refers to "the interposition of an open-circuited bowl classifier between the primary and secondary closed circuits" as being "a distinct innovation in grinding practice during 1928," and further goes on to remark that "Cananea, Chino, and Ray are at present installing open-circuited bowl classifiers for intermediate classification similar to that at Copper Queen."

In this connection and for the sake of

accuracy, the following is submitted for your columns:

Open-circuited bowl classifiers for intermediate classification have been in operation at "Ray"—i.e., the Hayden plant of the Nevada Consolidated Copper Company—since September, 1923. Excepting for the tables which were in operation between the fine-crushing circuit and the fine-grinding circuit, the standard flow sheet at Hayden since 1923 has been as follows: Fine-crushing circuit producing a 14-mesh product. Product of the fine-crushing circuit to an open-circuited 8x28-ft. bowl type drag classifier with an 18-ft. bowl. Overflow of the bowl to flotation. Rake discharge of the bowl classifier to the fine-grinding circuit. Product of the fine-grinding circuit combined with the bowl classifier overflow, and thence to flotation.

The installation of the open-circuited bowl classifier between the fine-crushing and fine-grinding circuits resulted in an increase in the capacity of the fine-grinding mills and also assisted in the elimination of the thickeners ahead of flotation.

Further data on the above are available by reference to Mr. Robie's article entitled "Impressions of the Ray Copper Concentrator" in the July 28, 1928, issue of the *E.&M.J.* and to an article entitled "Remodeled Flow Sheet at Hayden Plant" in the May, 1926, issue of *The Mining Congress Journal;* or through the Western representatives of The Dorr Company.

W. I. GARMS,
Mill Superintendent,
Nevada Consolidated Copper.

Hayden, Ariz.

Braden Assists in Chilean Rehabilitation

To the Editor of "E.&M.J.":

In your issue of Feb. 2, on page 214, you have an article regarding the copper companies' helping to build the Chilean school. You may be interested in knowing that the Braden Copper Company also donated 50,000 Chilean pesos for this purpose.

JOHN K. MACGOWAN,
Vice-president, Braden
Copper Company.

New York City.

What Constitutes a Record in Shaft Sinking?

To the Editor of "E.&M.J.":

I noted with interest the paragraph on page 635 of your issue of Oct. 20, 1928, upon the sinking record established at the Betty Shaft of the Sub Nigel, Ltd., in August of this year.

Reviewing the data given in *Engineering and Mining Journal* in 1921 and 1922 in connection with the world record-breaking performance at the Water Lily shaft, Eureka, no mention is made of the depth at which the 427.5 ft. were sunk during one calendar month. It would be of interest to know this.

The particulars for the Betty shaft given below may be of sufficient interest for publication. From Aug. 1 to 31, 1928, both days inclusive, 320 ft. were sunk from a depth of 857 ft. to 1,177 ft. in typical hard Witwatersrand quartzite. Details are as follows:

Number of compartments	5
Dimensions outside timbers	31 ft. 2 in. x 7 ft. 10 in.
End plates and wall plates	8 x 8 in.
Dividers	7 x 8 in.
Size of compartments inside timbers	5 ft. 6 in. x 6 ft. 6 in.
Number of rounds	93
Feet drilled per round	291
Explosive per foot sunk (60 per cent gelignite)	30.16 lb.
Capacity of buckets	41.6 cu.ft.
Number of buckets hoisted per round	39.3
Footage timbered	323 ft.

W. E. TURVEY,
Consulting Engineer,
New Consolidated Goldfields, Ltd.
Johannesburg,
Transvaal, South Africa.

[Mr. Turvey's point is well taken, and the logic of his inference is accepted—that a comparison of shaft-sinking records is not fair unless the conditions prevailing are similar. The information requested in regard to the Water Lily record, however, has been published several times in *Engineering and Mining Journal.* In the issue of July 23, 1921, page 146, readers were informed that "The start was made at 8 o'clock in the morning, at which time the measurement from collar to bottom, made by certified engineers, was 115.5 ft." A sworn statement giving the same information appeared in the issue of July 30, 1921. Details of the entire performance were given in the issue of Sept. 3, 1921. Of interest to note is the statement that "The first 367 ft. of sinking passed through a porphyry formation that proved to be favorable mucking material but offered difficulties in drilling on account of its sticky character. The last 60 ft. consisted of what is known locally as white lime shale—a moderately hard, close-grained limestone."

The Water Lily performance constituted a world's record, and a gold medal was awarded by *Engineering and Mining Journal.* The performance at the Betty shaft of the Sub Nigel, details of which are now supplied by Mr. Turvey, also constituted a world's record—for sinking, in hard quartzite, from an initial depth of over 800 ft. If some of our readers will suggest how an achievement of this character can be evaluated for comparison with other achievements in shaft sinking, allowance being made for all influencing factors, *Engineering and Mining Journal* will feel privileged to offer a gold medal for the best average daily shaft-sinking performance during any one month in 1929. We have the temerity to suggest that the presidents of the A.I.M.E., the Canadian Mining Institute, the Institution of Mining and Metallurgy, the Chemical, Metallurgical and Mining Society of South Africa, and the Australasian Institute of Mining and Metallurgy might be willing to act as judges —EDITOR.]

By The Way

"It's the Mining Game"

BY M. K. MEISEL

Bedrock, rigid granite, labyrinthine hills;
Scrape of pick and shovel; pounding of the drills;
Drip of copper water; spit of carbide lamp;
Hiss of air escaping; tap of powder tamp.

Grinding of the motors; closing of the gates;
Down-grade cars a-jamming; thud of signal weights;
Timber hoists exhausting; dropping of the bars;
Stoppage of the motor; knock of banging cars;

Station calls a-buzzing; hammering of steel;
Chuck tender's vivid cussing; rhythmic turn of wheel;
Powder monkies straining up the timbered slopes;
Narrow manways dripping stout manila ropes.

Miners in the crosscuts; nippers rushing drills;
Timbermen a-sweating putting in the sills;
Ore cars on the turn sheet; muckers in the drift;
Someone on the lagging, tapering off the shift;

What is there about it that we stay below?
Sweating, choking, cussing, asking "What's the show?"
Irishman and hunkie, Cousin Jack and Swede,
Men from every country, men of every breed?

Cramp of knotted muscles; copper-eaten back;
Splitting powder headache; cave-in down the track;
Man, we grin and bear it—curse it just the same;
And yet, somehow we like it. It's the mining game.

Personal Notes

L. D. Gordon has returned to Round Mountain, Nev., from New York.

H. C. Bacorn, of Jardine, Mont., has been in New York and Washington during the last two weeks.

John Bendel, mechanical engineer for the Cerro de Pasco Copper Corporation, is in San Francisco on a vacation.

L. O. Goodman, president of Ardsley Butte, recently returned to Butte from Boston.

John Hardy, who is in charge of the Leadville Development Corporation, is in New York.

F. A. Robbins, mining engineer, has been in New York on professional business.

Fred Snow, mining engineer, of Los Angeles, has been doing professional work in Nevada and Colorado.

Charles Hardy has returned to New York, after a trip of about two months in Europe.

A. W. ALLEN

W. A. Doman was erroneously described in the issue of Jan. 26 as editor of *The Financial Times.* Mr. Doman is editor of *The Financial News,* of London.

W. O. C. Ross, deputy inspector of mines for the Pretoria district, of the Union of South Africa, has been transferred to Bloemfontein.

Forest Rutherford, consulting metallurgist, 50 Broad St., New York City, is now in London, on professional business.

C. N. Schuette, representative of the U. S. Bureau of Mines, has returned to San Francisco after a study of quicksilver operations in Texas and Arizona.

Captain **James A. Stader,** assistant to the president of the American Zinc Institute, was a visitor to the Joplin district last week.

Thomas F. Cole, director of Calumet & Arizona and New Cornelia, who is also interested in several Nevada mines, has returned to Pasadena, Calif., after spending two weeks in New York.

David B. Gemmill, president of Prince Consolidated, which operates in the Pioche district of Nevada, was recently in Salt Lake City, before leaving for Mexico City.

Major **James McMillan,** recently chief inspector of mines for Ontario, is going to Uruguay to assist the government there in the development of the country's mineral resources.

G. A. F. Molengraff, professor of geology at the technical high school at Delft, Holland, will attend the International Geological Congress, to be held in Pretoria this summer.

H. M. Williamson and **Lewis E. Ashbaugh,** Denver mining engineers, have organized the Empire Engineering Company, with headquarters in the Tabor Building, Denver, Colo.

Dr. **S. P. Alexandroff,** Russian mining engineer, recently visited the molybdenum mines at Climax, Colo. He is representing the Moscow mining and chemical trust.

Newton W. Emmens has been appointed consulting engineer in western Canada for North American Mining & Smelting, a subsidiary of the Associated Metals Corporation. Mr. Emmens will make Vancouver, B. C., his headquarters.

Francis A. Thomson, president of the Montana State School of Mines, is in charge of the activities of the Bureau of Mines and Geology of Montana, which is a part of the research interests of the school.

A. W. Allen, editor of *Engineering and Mining Journal,* and **H. W. Clarke,** publishing director of *Engineering and Mining Journal* and *Coal Age,* will leave New York on March 2 for England and Continental Europe. They expect to be away for about seven weeks.

Dr. **F. Rothe,** director of the Kali Chemie Corporation, Berlin, Germany, recently visited the Utah Copper mine, at Bingham, Utah, and metallurgical plants in the vicinity of Salt Lake. From Salt Lake, Dr. Rothe went to Butte.

W. R. Wade, mining engineer with the John Hays Hammond interests in New York, sailed on Feb. 21 for Panama. He will be engaged for several weeks in exploration work in Central America and the West Indies. Mrs. Wade is accompanying him.

J. MacIntosh Bell, accompanied by **H. G. Acres,** a hydraulic engineer, is visiting the Henderson mine, near Smithers, B. C., in the interest of Mines Issues Corporation, of Toronto. This company recently acquired a large interest in Duthie Mines, which owns the Henderson.

L. McColgin, ore buyer for American Zinc, Lead & Smelting, has resigned to accept a position with the newly formed Allen Zinc Ores Sales Agency, in the Tri-State district. Mr. McColgin will be succeeded by **L. Mullins,** who has been in charge of the Douthat mine of American Zinc, Lead & Smelting.

Norman C. Stines, for many years consulting engineer for U. S. Smelting Refining & Mining, has joined **Howard K. Dutcher,** hydraulic and civil engineer, of Vancouver, B. C., in partnership. The new firm will be known as Dutcher, Stines & Company and will have its offices in the Metropolitan Building, Vancouver, B. C.

H. W. CLARKE

Frank H. Probert, dean of the College of Mining, University of California, will participate in the World Engineering Congress to be held at Tokyo, Japan, in October, 1929. The American committee of the Engineering Congress selected as representatives of the mineral industry are **George Otis Smith,** Director of the U. S. Geological Survey; **Mark L. Requa,** of San Francisco; Dr. **C. K. Leith,** of Madison, Wis., and **Frank H. Probert,** of Berkeley, Calif. Dr. Smith will present the subject of solid fuels; Mr. Requa, petroleum from a world viewpoint; Dr. Leith, the iron and steel industry, and Mr. Probert will discuss the treatment of non-ferrous metals. The Congress will convene on Oct. 25 for a two-week session.

OBITUARY

Frank Croman, mine operator, was killed recently when he fell in an old stope at the Durant mine, Aspen, Colo. Mr. Croman was 70 years old.

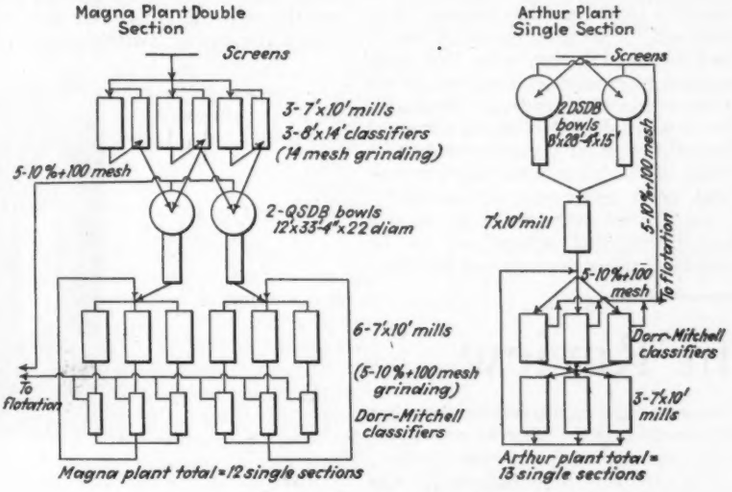
John A. MacDonald, who was formerly in charge of properties in various districts in Colorado, Nevada, Montana, and Sinaloa, Mexico, died at Nashua, N. H., recently. Mr. MacDonald, who was 85 years old, came to the United States from Scotland when he was quite young.

W. H. Seagrave died on Feb. 5, 1929, at Los Angeles, Calif. Mr. Seagrave graduated from the University of Nevada Mining School in 1896 and was one of several Nevada mining graduates who went to South Africa. He was underground manager of the Simmer & Jack mine. On his return to the United States he was, for several years, manager of the Kennecott mine, in Alaska. Mr. Seagrave had resided in Los Angeles for the past year. He was a member of the A.I.M.E.

INDUSTRIAL PROGRESS

Utah Copper Company to Install 56 Classifiers

IN THE latter part of January, 56 desliming classifiers were ordered by the Utah Copper Company from The Dorr Company. The Utah company formerly used suction-box classifiers which are no longer operating because of the abandonment of table work. The accompanying flow sheet shows the effect of this new equipment on the arrangements at the company's Magna and Arthur mills. Magna mill has twelve sections and a maximum capacity of 36,000 tons per day and a normal high of 32,000 tons. Arthur mill has thirteen sections and a maximum capacity of 30,000 tons and a normal high of 26,000.



Flow sheet showing effect of new classifiers on arrangement of equipment at Magna and Arthur plants

At Magna, eighteen 7x10-ft. primary mills (or mills of equivalent capacity) were authorized, each of which will operate in closed circuit with a DSD 8x14-ft. Dorr classifier, grinding to approximately 14 mesh. The primary classifier overflow will be deslimed in twelve quadruplex Model D Dorr bowl classifiers, 12 ft. x 33 ft. 4 in. x 22 ft. in diameter, the 5-10 per cent + 100 mesh overflow from which will join the secondary classifier overflow and go to flotation while the slime-free rake product will be reground in 7x10-ft. secondary mills in closed circuit with Mitchell type classifiers.

At Arthur twenty bowl classifiers, 8 ft. x 28 ft. 4 in. x 15 ft. diameter, will be used for the primary desliming of the impact screen undersize. The overflow of 5-10 per cent + 100 mesh will go direct to flotation, and the clean rake products will be ground in 13 7x10-ft. primary mills.

As a result of these changes in Utah's two mills, Magna will get open-circuit bowls and primary classifiers to handle the world's maximum plant tonnage. Arthur will have the largest installation of bowl classifiers in number of machines to date.

The Utah job is significant from more angles than just those of competitive selling and volume marketing. The decision to purchase Dorr instead of Mitchell classifiers for these two mills possibly forecasts the replacement of existing Mitchells with Dorrs in the not too distant future. The Mitchell classifier was developed by one of the Utah company's own men, and although the Dorr Company controls the patents, the Utah company has the right to manufacture Mitchells in its own shops for its own use. Purchase of the bowl classifiers also is considered an important decision, inasmuch as the Utah company expressed itself as opposed to the bowl principle several years ago after operating three of them in its mills.

With copper quoted today at the existing high prices, the outlook is bright for the industry as a whole. The Utah order is an example of how far-sighted companies are willing to spend large sums of money for improvements and thus capitalize the general prosperity they are now enjoying.

The Dorr Company's background in respect to this installation at the Utah plant was the Ray Mines' installation of several years ago and the Nevada Mines' installation of thirteen bowls, recently completed.

The maximum capacity of the Nevada company's plant is about 20,000 tons per 24 hours. Equipment includes 27 Model D 6-ft. classifiers in closed circuit, thirteen type DSDB bowl classifiers desliming crushed feed ahead of the fine-grinding section, seven No. 2 duplex suction pumps feeding milk-of-lime, three 75-ft. concentrate thickeners, eleven 50-ft. tailing thickeners, and one 14x14-ft. filter. Four suction box classifiers are now idle most of the time. These are used only when Oliver filters are in operation.

At the Chino plant the maximum capacity is about 14,000 tons per 24 hours. The fine-grinding flow sheet is now in the course of revision, and when it is completed there will be in operation 14 open-circuit bowl classifiers and 20 closed-circuit 8-ft. Model D classifiers. A special type of primary classifier is now on order. The plant has three 75-ft. concentrate thickeners and a 12x 12-ft. Dorrco filter.

Ray has a maximum capacity of about 12,000 tons per 24 hours with seven open-circuit bowl classifiers, 8 ft. x 28 ft. 4 in. x 18 ft. in dimensions, and fourteen 8 ft. x 28 ft. 4 in. Model D classifiers in closed circuit. The concentrate is settled in three 75-ft. thickeners. At the plant a 14x14-ft. Dorrco filter is now awaiting installation.

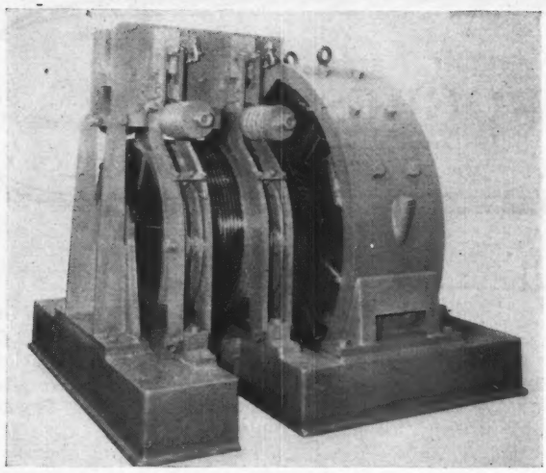
The Miami Copper Company, after purchasing recently two 20 x 42-ft. x 28-ft. diameter quadruplex Dee Dorr bowl classifiers, has ordered four additional units of the same size.

Traction-Type Motor Applied to Mine Hoist Service

By H. W. Chadbourne
Industrial Engineering Department, General Electric Company

THE Phelps Dodge Corporation recently installed at Morenci, Ariz., a hoisting equipment which is unique by reason of the fact that it utilizes a gearless traction-type elevator motor. This is the first time such equipment has been applied to a mine hoist, the usual application being passenger elevators in large buildings.

The motor is rated at eight poles, 140 hp., 85 r.p.m., 250 volts. It is



This mine hoist is equipped with a traction-type motor

shown in the accompanying illustration. By building the motor and hoisting drum as one unit, the construction has been simplified. The motor is mounted in the headframe over the shaft, thus eliminating the separate drum on the ground. Incidentally it is the largest of its type built for any service.

The installation is of further interest in that the hoist is of the mixed-duty type. The mine shaft is 800 ft. deep, and the hoist, operating at a rope speed of 400 ft. per minute, raises and lowers men and carries supplies. In addition, it will also haul some ore.

Besides the simplification of equipment, there is a further advantage in the use of this type of hoist motor: Standard elevator-type control may be used, which is more accurate than that customarily used on mine hoists. This control will be of the variable-voltage (Ward Leonard) type, with the panel and motor-generator set mounted in the hoist house on the ground. Normally, the hoist will be controlled by the cage tender, although a master switch is provided in the hoist house for controlling the hoist movement if necessary. The two control stations, however, are so interlocked that operation can be governed from but one point at any time.

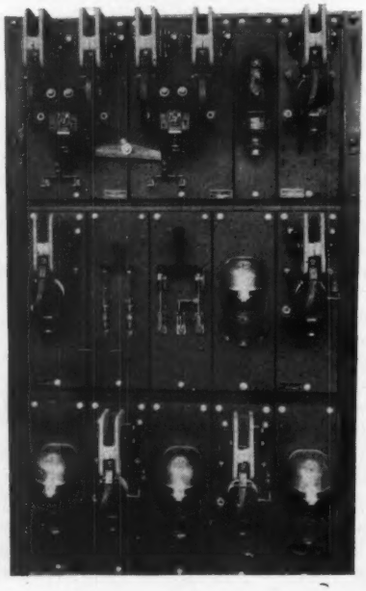
The Equipment Review

A DOUBLE-DRUM electric hoist, which will be one of the largest in the Southwest and will incorporate the latest control devices and safety features, is to be installed by the Calumet & Arizona Mining Company at its Campbell shaft at Warren, Ariz. The hoist will be furnished by the Allis-Chalmers Manufacturing Company. It will have 10-ft. diameter drums to wind 3,800 ft. of 1⅜-in. rope in two layers. It will be designed for a maximum rope pull of 31,300 lb. and will operate at a speed of 2,000 ft. per minute. Both drums will be clutched, the brakes and clutches being actuated by oil-operated auxiliary engines. The unit will be driven by a 1,350-hp., 550-volt, 400-r.p.m. d.c. motor connected to the hoist through a single reduction of Falk gears. This motor will be supplied with a motor-generator flywheel set, consisting of 1,000-hp. induction motor coupled to a 1,250-kw. generator, and will have a plate wheel mounted at the end of the set, the weight of the wheel being 62,000 lb. with shaft and coupling. The wheel will be coupled to the set in order that it may be left disconnected for a year or so on account of the lighter loads which will be handled at that period.

A New System of Electric Control

A time-current system of control (not time limit nor current limit) has been developed by the Electric Controller & Manufacturing Company, of Cleveland. This system uses an acceleration relay which operates on an entirely new principle and has remarkable characteristics, according to the manufacturer. On light loads it gives maximum output, and on heavy loads longer time up to 2 sec. per step is had automatically without any change in adjustment. On normal loads, forced acceleration gradually increases the torque until the motor eventually starts. In addition to these, the time-current acceleration relay has all the advantages of existing systems of acceleration.

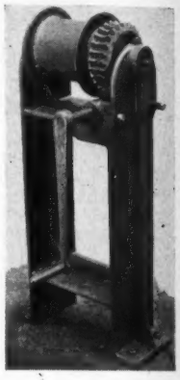
Panel embodying new system of time-current control



New Switches of Wide Application

A new line of cam-operated double-brake master and limit switches has been announced by General Electric. The limit switches are expected to be of especial value on such applications as skip hoists, car dumpers and other machines requiring geared type switches. In general, the master switches are for the same type of service as the others.

The limit switches can be adjusted by shifting, tripping, and closing dogs on the cams. The contact mechanism is of the snap-action type and is latched in both the open and closed position. This gives a positive action to the switch and also allows adjustment of the operating dogs to work the contact mechanism through the entire 360 deg. of rotation. The master switches are available in three forms—namely, one-, two- and three-point.

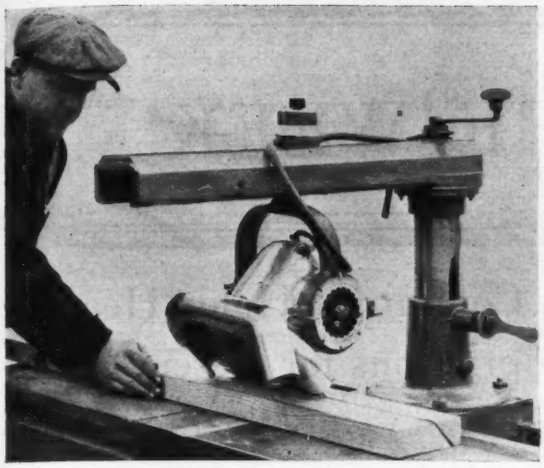


A light and portable floor-type winch

The switches have the following features: double-brake silver-faced contacts; no shunts to break and burn off; freedom of contact parts from dust and other accumulations; molded insulation on cams and contact arms; accessibility of molded terminal board for wiring; tips easily renewed and common to all devices in the line; and small over-all size and compact design.

This Winch Is Light and Portable

A floor-type, hand-operated winch has been added to its line by the Stephens-Adamson Manufacturing Company, of Aurora, Ill. It is mounted on a cast-iron stand, which is strongly built, though light. It has a cast-iron worm gear which is self-locking, insuring the safety of the load at all times. The winch has a rope pull of 750 lb. at the drum. The latter is of cast iron, is 6 in. in diameter, and has a capacity of 100 ft. of ¼-in. cable and 60 ft. of ⅜-in. cable. Height from the top of the drum to the floor is 34 in., and the over-all width 18 in. The hoist is attached to the floor by means of four bolts in the cast-iron stand base. Its light weight and portability make it useful in any part of a plant. It is provided with high-pressure lubrication fittings.



This woodworking machine will perform 29 distinct cutting operations

A Portable Electric Woodworking Machine

A woodworking machine that simplifies any single cutting operation, and yet has so many varied uses that it can be substituted for several other machines, has been introduced by the DeWalt Products Corporation, Leola, Pa. This machine, which is known as the DeWalt Junior, has balanced guided power which is applied to the saw in all cutting positions. Without stopping the motor, the saw may be changed from cross-cutting to ripping. It is provided with an accurate ripping gage and dial for adjusting it to any position. It has a Universal motor, which operates from any cycle in either a.c. or d.c. by plugging into a light socket. The machine will perform twenty-nine distinct cutting operations. It is shown in the accompanying illustration when ready for use the device is fitted on a wooden table 29 x 59 in. in dimensions and weighs, complete, 235 lb.

Protection for Motor and Feeder Circuits

A line of small inclosed air-break circuit breakers ranging in capacity from ½ to 80 amp., 250 volts d.c. and 550 volts a.c., has been introduced by the Roller-Smith Company, 233 Broadway, New York. These circuit breakers are intended for the protection of motors and feeder circuits against the overload and failure of voltage. Their characteristic features are: non-closable on overload; simply operated; provided with barriers between poles and arc chutes; and the overload coils can be replaced with new coils of the same capacity or any other listed capacity by the man on the job. The new direct-acting time limit resets itself instantly after the breaker opens. In addition, all parts are easy to get at and abundant wiring space is provided at the top and bottom; likewise knockouts at the top, bottom and sides.

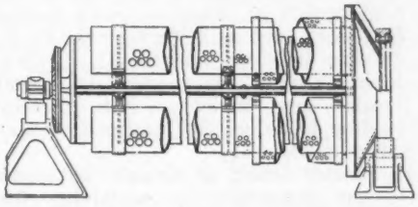
For the Shop

Three sets of socket wrenches have been introduced by the Blackhawk Manufacturing Company, Milwaukee. They are of chrome-vanadium steel, chromium plated, and have other features, including double-hexagon sockets and lock-on sockets which may be quickly detached when necessary.

PATENTS

ROTARY SCREENING APPARATUS. No. 1,698,572. Jan. 8, 1929. James Watt, Westbury-on-Trym, England, assignor to J. & F. Pool, Ltd., Hayle, England.

An improved rotary screening apparatus comprising a number of compartments, each of which contains screens of circular cross-section that are mounted in alignment



and provided with perforations of successively increasing size. These screens are fixed about a central shaft formed by a number of arcuate plates having concave sides. Material to be screened is delivered directly to the screens having the smallest perforations that are at one end of the compartments.

TITANIUM OXIDE FROM TITANIFEROUS IRON ORES. No. 1,699,173. Jan. 15, 1929. Carl Raymond Whittemore, Montreal, Canada.

This process of preparing titanium oxide from titaniferous iron ore comprises reducing the iron content to sponge iron without fusion or sintering, cooling in a non-oxidizing atmosphere, and separating the sponge and titanium content from the non-magnetic portion. The treated ore is then dissolved with a solvent, and the residue heated with an acid to 250 deg. C, in a digester to form titanium salts. After having been disintegrated, the mass is lixiviated with cold water, and the solution hydrolyzed to precipitate titanium hydroxide. The precipitate is then calcined.

WASHING PLANT. No. 1,699,962. Jan. 22, 1929. Antoine France, Liege, Belgium.

A plant for washing coal and other minerals that utilizes differences in specific gravities as a means of classifying materials conveyed along an inclined launder by a liquid stream.

SEPARATING PRECIOUS METALS AND COPPER FROM CYANIDE SOLUTION. No. 1,699,350. Jan. 15, 1929. Lionel H. Duschak, assignor to Oliver Continuous Filter Company, Oakland, Calif.

This method of precipitating precious metals and copper from cyanide solutions consists in treating the solution with an amalgam containing a metal electro positive to copper for a short period to remove the precious metals. The solution is then treated with a separate portion of an amalgam of the same character for a longer period to remove the copper. This solution is reused in further operations to treat a fresh quantity of ore.

INDUSTRIAL NOTES

Nearly 100 representatives attended the twelfth annual convention of the technical section of the explosives department of E. I. du Pont de Nemours & Company at Wilmington, Del., recently. Arthur La Motte, manager of the Technical Section, presided. "The Activities of the Year" formed the keynote on which numerous papers were based and scores of written questions and statements were presented. J. Thompson Brown, general manager of the explosives department, addressed the convention at the opening session. Pellet powder, which was introduced in the American mining industry by du Pont, was a principal topic of discussion. In this connection, the fact was developed that a high percentage of the du Pont black powder mill production is now pellet powder, whereas 40 per cent of the total sales of black powder is for use in coal mines. Safety in the underground handling of explosives and co-operation among mine officials and company technical men with a view to the more efficient uses of permissibles and other types of powder were given full consideration.

J. Spotts McDowell has been appointed director of research of the Harbison-Walker Refractories Company, Pittsburgh, Pa. The scope of the company's research work will be broadened at the central laboratory in Pittsburgh, and, in general, control work to insure uniformity of product will to a large extent be handled in the smaller laboratories at the individual plants. Mr. McDowell, who has been connected with the Harbison-Walker Refractories Company for about twenty years, is well known to the refractories and allied industries through his contributions to technical literature and his activities in the American Ceramic Society, the American Society for Testing Materials, the American Refractories Institute and other societies of which he is a member. He is a graduate in mining engineering of the Massachusetts Institute of Technology.

Cutler-Hammer, Inc., of Milwaukee, Wis., announces that it has acquired the business of the Trumbull Vanderpoel Electric Manufacturing Company, of Bantam, Conn., which will be operated as a subsidiary under its present name. This purchase will add a complete line of meter service and safety switches to the present Cutler-Hammer line of motor control, wiring devices, and similar electrical equipment.

NEWS OF THE WEEK

Summary

CONSOLIDATED Mining & Smelting, and Ventures, Ltd., representing the Lindsley interests, have announced construction of a copper refinery in eastern Canada—the second announcement of this sort to be made within two weeks.. An electrolytic zinc plant will also be built. Page 333.

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Considerable interest is being evinced in copper properties in the area between Superior and Miami, Ariz. Magma Copper is sinking a new shaft in this district.. Page 334.

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Steam shovel operations at Sacramento Hill will be discontinued in April and glory-hole methods substituted. Page 332.

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Quincy Mining has cut the east vein on the bottom level of its No. 2 shaft at its property in the Michigan copper district. All three operating shafts are now being deepened. Page 334.

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Development of the Monarch group of mines, near Field, B. C., is being carried on by Mining Corporation and Goldfield Consolidated. A cable tramway will be constructed to connect the mines with the new concentrator which will be built this summer. Page 335.

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A new Oklahoma metal-mining code was recently adopted unanimously by the legislature. It was written by the inspectors for the Miami district. Page 332.

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Miami Copper will have a daily capacity of 16,000 tons when changes now being made are completed. Page 331.

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The crosscut on the 1,400 level at Golconda Lead, in the Coeur d'Alene district, struck the orebody 310 ft. from the shaft. Mill capacity will probably be increased to 400 tons daily. Page 333.

Senate Mines Committee Holds Hearing on Appropriations for Research

By Paul Wooton
Special Washington Correspondent

THAT the mining industry is not receiving its share of federal appropriations allotted to research work and economic studies again was demonstrated on Feb. 15 before the Mines and Mining Committee of the Senate. The committee also heard testimony indicating that a more liberal policy would be one of the most effective steps the government could take in the interest of conservation and that it has the support of taxpayers who realize that work such as is done by the U. S. Bureau of Mines and the U. S. Geological Survey has practical value and creates new taxable wealth, thereby tending to reduce the burden each taxpayer must bear.

Senator Oddie, of Nevada, chairman of the committee, in explaining the reason for the hearing stated that the mining industry has not received equal treatment because it never has been regarded as possessing political influence. Scott Turner, the Director of the Bureau of Mines, was questioned at length by Senator Oddie and Senator Hayden, of Arizona. He was required to reveal the amounts he had requested for the different phases of work coming within the scope of the Bureau, together with the reductions made by the budget officer of the department and by the Bureau of the Budget. The imperative need for geological and topographic surveys was brought out by W. C. Mendenhall, chief geologist of the Geological Survey.

The need for increased appropriations for the Bureau and the Survey was also stressed by H. A. Buehler, Director of the Missouri Bureau of Geology and Mines; by George H. Ashley, State Geologist of Pennsylvania; and by E. F. Bean, State Geologist of Wisconsin.

An extract from the transcript of the examination of Director Turner, in which important points were brought out, is as follows:

Senator Oddie. Tell the committee of the total amount of the provisional estimates as submitted by you to the Department this year.

Mr. Turner. $3,478,283.

Senator Oddie. What was the amount finally approved by the Department?

Mr. Turner. $2,778,398.

Senator Oddie. What is the difference between the two?

Mr. Turner. $699,885.

Senator Oddie. Then this amount was cut from your estimates by the Department after a careful study of your requirements?

Mr. Turner. I presume our requirements were given careful consideration by the Department.

Senator Oddie. You, of course, and other officials of the Bureau, were called into conference with the Department officials before such drastic cuts were decided upon?

Mr. Turner. No sir, we had no conference with Departmental officials as to our estimates.

Senator Oddie. Do you mean there was no conference of any description by the fiscal officers of the Bureau in regard to finances?

Mr. Turner. No conferences, as far as I know.

Senator Oddie. Then what machinery is provided for you to express to the Department your ideas as to the many requirements of the Bureau?

Mr. Turner. No machinery except a request that provisional estimates be submitted to the Department.

Senator Oddie. Neither before nor after the provisional estimates are made by you to the Department or the preliminary estimates are prepared, or before the regular estimates are approved by the Department, is there any study or consideration by the officials of the Department and Bureau?

Mr. Turner. None that I know of.

Senator Oddie. I had supposed that a proper financial program for the Bureau could not be derived by the Department without several meetings and discussions with Bureau officials. How about the Bureau of the Budget—does it give you opportunities to discuss in person your requirements?

Mr. Turner. Yes sir, they hold regular hearings on our estimates.

Senator Oddie. What was the amount of your estimates as sent the Bureau of the Budget by the Department of Commerce?

Mr. Turner. $2,778,398.

Senator Oddie. What was the amount as revised by the Bureau of the Budget?

Mr. Turner. $2,249,670.

Senator Oddie. Then what reduction was made by the Bureau of the Budget?

Mr. Turner. $528,728.

Senator Oddie. And the reduction by the Department itself was how much?

Mr. Turner. $699,885.

Senator Oddie. Then after the Bureau had prepared its careful estimates of the requirements of the year 1930, these estimates were reduced $699,885 by the Department of Commerce without any conference whatever with you as to your needs, then by $528,728 by the Bureau of the Budget, after they had extended you the courtesy of a hearing in regard to your requirements?

Mr. Turner. Yes sir.

Senator Oddie. What does that make the total reduction that the Bureau suffered this year on account of the Department and the Bureau of the Budget together?

Mr. Turner. $1,228,613.

At the request of the committee Director Turner agreed to furnish for the record copies of letters showing the feeling in the industry growing out of the appropriations situation and letters tending to show that the work being done by the Bureau is regarded as meritorious.

Senator Hayden could get only noncommittal answers from Director Turner and Mr. Mendenhall to questions as to the advisability of returning the Bureau of Mines to the Department of the Interior, but Mr. Buehler declared emphatically that the Bureau of Mines and the Geological Survey should be in one department.

Two Minnesota Counties Issue Reports on Mining

REPORTS of the mine inspectors of Itasca and Crow Wing counties, Minnesota, covering operations at the iron mines during 1928, have just been published.

In Itasca County, which includes the western end of the Mesabi range, 6,991,543 tons of ore was shipped, and 6,531,858 yards of overburden stripped. The total number of men employed was 3,384, of whom 321 were employed in the sixteen ore-washing plants. The average wage of the mill workers was $4.85; that of the miners, $5.23. Reports show that the fatality rate was only .08 per 1,000 men employed. The inspector reports that washing plants will be erected in 1929 at Keewatin, Taconite and Grand Rapids. There were 89 steam and electric shovels in operation in 1928. One of these has a working weight of 550 tons, with a 10-yd. dipper, the handle of which is 48 ft. long.

Crow Wing County includes all of the Cuyuna range, the newest of the six Lake Superior iron-ore ranges. Eighteen mines were in operation in the county last year out of a total of 40. The underground mines employed 439 men; the pits, 474. There were 144 additional working on surface and 75 in the plants. The tonnage mined was 2,168,878, of which 115,546 tons was sintered. The stripping totaled 1,609,953 yards. On the range are one washing plant, two crushing plants, one drying plant, and one sintering plant. One fatal accident occurred during the year.

Pacific Copper Company Will Be Liquidated

LEGAL proceedings have been instituted by St. Mary's Mineral Land to wind up the affairs of the Pacific Copper Company and dispose of and distribute the property of the Pacific, in the Michigan district, among the stockholders and creditors. The bill also provides for the appointment of a receiver of the Pacific property, which consists of 808 acres of mineral land; $15,000 par value of U. S. Liberty bonds; $5,000 par value of U. S. Treasury notes; and $21,383.45 in cash. The action, if contested, must be answered on or before May 15, 1929.

Pacific is controlled, through ownership of one-half of the total stock issue, by the St. Mary's company. The capitalization is $1,250,000, shares, $25 par; issued, $1,000,000, $2 paid. The property lies northwest of the old Atlantic mine, and carries the northern extension of the Atlantic ashbed.

A merger of the Atlantic, owned by Copper Range, and Pacific properties has been rumored, the purpose having for its objective a hastening of the development of the ashbed. This work would be done by Champion Copper, in which Copper Range and St. Mary's each have a half interest, but no definite steps have as yet been taken.

Chilean Nitrate Port Destroyed by Fire

THE nitrate port of Caleta Buena was destroyed by fire which started after midnight, Feb. 11, in a motion picture theater, according to a cable dispatch to the New York *Herald Tribune*. The bodies of three persons burned to death were found under débris. Several nitrate piles were burned and inhabitants of the village fled to the hills, fearing the fire would blow up two large tanks containing 4,000 tons of oil. Nitrate losses are believed to be high.

Take Diamond Drill to New Crow River Area

ARRANGEMENTS have been made to ship a diamond drill to the Connell option, in the new Crow River area, Ontario. The drill and all camp supplies will be taken in by the Western Canada Airways planes. A series of shallow drill holes will be put down to a maximum depth of 200 ft. to check surface results. Sampling of surface trenches showed ore for a length of 550 ft. and a width of 19.3 ft. The Western Canada Airways has established a base on the Canadian National Railroad, about 70 miles east of Sioux Lookout, and is operating three planes into the district. Northern Aërial Minerals Exploration group, east of the Connell option, is also obtaining good results. The N.A.M.E. will probably take in a diamond drill, as well as the necessary supplies and food for this operation, with its own planes. Diamond drilling under these conditions is not as expensive as might be anticipated. Last year the Connell group did considerable diamond drilling at Favorable Lake, with a gasoline-driven machine taken in by airplane, and the total cost was approximately $6 a foot.

Miami Will Increase Output to 16,000 Tons Daily

By Special Telegraph to Engineering and Mining Journal

Miami, Ariz., Feb. 19, 1929—Completion of present improvements at the Miami Copper mine, Miami, Ariz., will increase the production of this property from 12,000 to 16,000 tons daily, F. W. Maclennan, manager of the company, has announced. New ore cars and motors have been supplied. The hoist is being speeded up from 1,500 to 2,200 ft. per minute by installing a new motor and a new motor generator set, consisting of 1,100 hp. motor and 1,000 kw. plant. A new 7-ft. Symons cone crusher is being installed in the crusher department. Concentrator capacity will be increased by six 10 ft. 6 in. by 8 ft. Williamson mills. Also six new 100-ft. Miami-Dunn flotation cells will be added, and six 15-ft. cleaner cells. Ore handled at Miami runs considerably under 1 per cent copper.

Consolidated M. & S. Options Gladstone Mountain

Gladstone Mountain Mining has optioned its property near Northport, Wash., to Consolidated Mining & Smelting, of Canada. According to the terms of the option, Gladstone Mountain will receive $20,000 and a quarter interest in a new company that will be organized by Consolidated to operate the property. Stockholders of Gladstone will vote on the proposal on March 1. The purchasers agree to work the mine, which is the largest lead producer in Washington, and pay a 15 per cent royalty to be applied on the purchase price, as ore is shipped. Consolidated has also acquired the adjoining Electric Point mine.

Vipond Developments Result in Mill Expansion

At the Vipond, in the Porcupine district, northern Ontario, development of the new orebody has been actively carried forward on four levels. The result has been, according to official statements, that ore reserves have been more than doubled, justifying a more comprehensive plan of development for the unexplored area. An additional crusher has been installed and milling capacity will be increased to about 300 tons daily. Vipond has joined the group formed by the Huronian Belt, Keeley, and Pioneer companies for exploration work.

Sacramento Hill, from which more than 10,000,000 tons of ore has been removed, in the Bisbee district

Steam-Shovel Mining at Sacramento Hill to Be Discontinued in April

Glory-Hole Methods to Be Used in Extraction Hereafter—Other Developments at Phelps Dodge Properties in the Southwest

STEAM-SHOVEL operations at Sacramento Hill, in the Bisbee district, Arizona, will probably be discontinued in April, according to P. G. Beckett, general manager of Phelps Dodge, which operates the mine. The ore remaining in the West orebody will be mined by glory-hole methods and hoisted through the Sacramento shaft. Hoisting of additional ore at this central hoisting shaft will necessitate some additions to the headframe, and also a new loading and track arrangement. These changes are now being made.

An extensive underground exploration program is now under way at the Copper Queen branch in the hope of finding new orebodies to replace those that are now being exhausted. Some of the exploration work will be done in the territory under and near Queen Hill, where the original Copper Queen orebodies were found and mined, and other work will be undertaken in the comparatively unexplored region to the south. Most of the present production from the Copper Queen is coming from ore mined on company account, but some is also being derived from leasers' operations. Lead ore is being mined in the southwest division and is being shipped to Douglas. Exploration work from the new Warren shaft has not yet encountered ore, but it is being continued.

At the concentrator at Warren operations are now at full capacity. In connection with the company's operations outside the Bisbee district, Mr. Beckett has made the following statements:

"At the Copper Queen smelter, at Douglas, three to four reverberatory furnaces are in operation, depending on tonnage available. The operations in both the copper and lead departments are at present largely of a routine nature and a normal number of men is being employed. Besides the lead ore from Bisbee, the lead department is smelting custom ores from different parts of the Southwest. The small test leaching plant for low-grade ores, recently erected at the smelter, has commenced operations, but many months must elapse before any conclusive results are obtained.

"At Nacozari no new construction work is being done and mining operations are being confined to the Pilares mine. The concentrates from the Nacozari concentrator are being shipped, as usual, to the Copper Queen smelter at Douglas.

"At Tombstone, leasers are producing a small tonnage of ore, part of which is being shipped to Douglas and part to El Paso.

"At the Morenci branch considerable underground development work is being done with a view to opening up lower levels of the mine. Also, some diamond drilling work is under way. At the Morenci concentrator additions are being planned in the crusher plant and on the primary grinding mill floor, which will increase the tonnage of the concentrator but which will not increase the copper production because of the lower-grade ore being treated.

"At the Clifton smelter, operations are mainly routine and, as during the greater part of last year, anodes are being shipped East. At Tyrone N. M. no work is being done."

New Oklahoma Metal-Mining Code Adopted

A METAL-MINING code, prepared by Charles A. Neal and John W. Newton, of Miami, Okla., presented to the Oklahoma legislature recently has been unanimously adopted by the legislature and will become a law as soon as it is signed by the acting governor.

A code combining both metal and non-metallic mining, prepared by M. D. Hay, chief mine inspector, was never presented to the legislature. Coal operators of the state were content to leave the coal mining statutes as they were, and no one could be found to introduce the measure in the legislature when they found the metal mining code did not interfere with present practices.

California Compensation Insurance Is Increased

CALIFORNIA has raised its rate for industrial compensation insurance 6 per cent, to take effect March 1. The basic rate for mining is now $8.04 per $100 of pay roll. The new rate will be $8.52, and is said to be the highest rate applying in any mining state. The new rate is established by the California Inspection Rating Bureau with the consent of the State Insurance Commissioner. Insurance carriers support the California Inspection Rating Bureau. There are about 48 companies writing compensation insurance in this state. According to some opinions, rates are padded about 35 per cent to take care of the private insurance companies. The State Compensation Insurance Fund has been successful in maintaining a lower rate than that of the private companies.

In addition to the basic rate charged for compensation insurance there is also an "experience rating" which increases the total rate for some mining companies to $13 per $100 of pay roll. Part of the rate is returned, varying from a maximum of 54 per cent to an average of about 15 per cent. The rate even with this return will be more than $7 per $100 of pay roll, under the new rating.

Deepen Shaft at Evolution

Evolution Mining has awarded a contract to William Stokes to deepen the shaft at its property in the Coeur d'Alene district 300 ft. Work has already been started and is proceeding on a three-shift basis. The shaft, which is on an incline, is already down 300 ft. from the tunnel level, but is only 145 ft. vertically below that point. On the drift west from the shaft, 8 ft. of low-grade milling ore has been cut.

Another Copper Refinery Will Be Constructed in Eastern Canada

Consolidated M. & S. and Lindsley Interests Will Combine to Build New Plant, Which Will Include Electrolytic Zinc Works—Location Has Not Been Made Public

TORONTO, Feb. 16, 1929—The announcement of the new Noranda copper refinery in eastern Canada was no sooner out than Consolidated Mining & Smelting announced that, in association with Ventures, Ltd., it would proceed with the immediate erection of a copper refinery and a zinc reduction works in eastern Canada. The location of the plants has been decided on, but the site has not yet been purchased. Both plants will be designed and built by the mechanical staff of Consolidated. The copper refinery will be somewhat larger than the Tadanac refinery of the Consolidated, but the zinc reduction works will be smaller than the Tadanac plant. Both will be designed so as to permit additions to be made readily and economically.

Consolidated is controlled by the Canadian Pacific Railway and Ventures, Ltd., is controlled by the Lindsley group. The combination of these interests is in many respects a logical one, in view of the well known desire of the C. P. R. to get as large a share as possible of the mining freight in Canada for its railroad and steamship lines. Consolidated brings into the combination plenty of money, experience in the construction and operation of plants of this kind, and a good marketing organization. In addition Consolidated has an option on what appears to be a very promising copper-nickel property at Rottenstone Lake in northern Saskatchewan. The Lindsleys control the Sherritt-Gordon, Sudbury Basin, Falconbridge Nickel, and other properties. Sherritt-Gordon will be producing blister copper and zinc concentrates from its properties in northern Manitoba and the deal will assure Canadian Pacific of a substantial proportion, at least, of the freight haul on these products. Falconbridge Nickel has announced the erection of a 200-ton smelter in the Sudbury district and will be producing nickel and copper. The Vermilion Lake property of Sudbury Basin is expected to be amalgamated eventually with the Errington mine of Treadwell Yukon and the new plant will probably obtain both zinc and copper concentrate from Treadwell Yukon.

The Lindsley interests, through various subsidiaries, are among the most active exploration organizations in Canada. They have a promising copper property at Oxford Lake in the district of Patricia, and at the present time are sending in a large expedition to Chesterfield Inlet. Supplies will be taken in by tractors. The company hopes to make the trip in three days by using shifts of drivers. This is one of the most ambitious undertakings ever attempted in Canada and will be the longest tractor haul ever made into the unprospected regions of this country.

In the meantime Noranda has placed orders for the steel work for its new refinery, although the location has not yet been announced. However, the statement has been made that it will be somewhere between Quebec and Montreal.

The one unknown factor in the situation is International Nickel, which will be producing more copper within two or three years than any other company in the British Empire. To visualize big combinations of this sort without Nickel playing a prominent part is difficult. That room for further expansion is being provided can be seen in the fact that the authorized capital of the International Nickel Company of Canada, as announced in the *Canada Gazette*, is 17,000,000 shares of no par value common stock. Originally the understanding was that the capital of the company would amount to 15,000,000 shares. The amount of common stock outstanding, after all of the Mond stock has been exchanged, will be less than 14,000,000 shares.

Golconda Strikes Orebody on 1,400 Level

Golconda Lead, operating in the Coeur d'Alene district of Idaho, struck the orebody, now being mined on the upper levels of its property, in the crosscut on the 1,400 level, 400 ft. below the main operating tunnel. The strike was made 310 ft. from the shaft about one week before the original estimates, which had placed ore about 350 ft. from the shaft. The orebody was 6 ft. wide where first struck, but showed increased width as development progressed. The company plans to increase capacity of the mill, which went into operation last fall, to 400 tons daily.

Mount Morgan Deal Not Completed Yet

Nothing further has been heard of the attempt to reopen the Mount Morgan gold mine, in Queensland, Australia, according to a dispatch from Brisbane dated Jan. 16. The deal referred to in *Engineering and Mining Journal* of Nov. 24 was never completed. Although the promoters claimed to have been underwritten, the option on the property was not exercised. Some mention has been made of the possibility of treating the 8,000,000 tons of ore remaining in the mine by leaching *in situ*, but no steps toward this end have yet been taken.

Cutting Loses Suit Over Independence Mine

THE U. S. Circuit Court of Appeals at San Francisco on Feb. 4, 1929, ruled that H. C. Cutting must transfer ownership of the Independence mine, on the Klamath River in northern California, to M. B. Bryan and S. K. Mulford, both of Philadelphia, Pa. Cutting was employed as a trustee to acquire property for the Buzzard Hill Mining Corporation, in which he had previously interested Bryan and Mulford. He contended that he was the sole owner of the Independence, a property subsequently added to the Buzzard Hill claims, which proved worthless.

Production Expected to Start From North Cananea

North Cananea Mining, which controls 665 acres adjoining the Greene-Cananea, in northern Sonora, has been financed by Canadian interests and is now preparing for production from the Penitas shaft, where development work has been carried on for the last two years. An extensive diamond drilling campaign in other sections of the property is also planned.

British Columbia Copper Mines Increase Wages Also

The Britannia Mining & Smelting Company gave its white employees at its properties in British Columbia an additional 25c. and its Oriental employees an additional 15c. per shift, effective Feb. 1, the increase to hold good as long as copper remains at or above 17 cents per pound. The Granby Consolidated Mining, Smelting & Power Company, which employs no Orientals, gave its employees a raise of 5 per cent, also effective on Feb. 1 and until the price of copper drops below 17c.

Monarch to Build Mill

Monarch Lead, operating the Tennessee mine, in the Chloride district of Arizona, has started construction of a new mill, which will have a capacity of from 125 to 150 tons daily. The mill will be built near the main shaft, now down 1,600 ft. The mine has a long production record and with the use of flotation the company expects to be able to treat considerable material formerly not worth shipping.

Kennedy to Reopen Soon

The first skip since the disastrous fire last fall, which destroyed all the surface workings at Kennedy Gold, near Jackson, Calif., was sent down the main shaft recently for inspection purposes. The shaft was not badly damaged, but water has risen to the 4,500 level. Two or three weeks will be required to unwater the mine before operations can be resumed.

Quincy Cuts East Vein on Bottom Level of No. 2 Shaft

QUINCY has cut the east vein in a crosscut from the 89, or bottom level, of No. 2 shaft, at its mine in the Michigan copper district. It is as wide as in the levels above and averages about the same grade. This vein has been opened in 86, 87, and 88 levels. In No. 6 shaft, the main lode has been cut in a crosscut from the 89, or bottom level. In the three levels immediately above, this vein widened out and increased in mineralization as the drifts proceeded northward.

All three operating shafts, Nos. 2, 6, and 8, are now sinking. Opening work is proceeding as rapidly as possible in the lower levels, but some time will elapse before the extent of stoping ground will permit large production. In January, 2,000 ft. of openings were driven. By spring it is hoped to bring this development work up to a half mile or more a month. In the mill, stamping continues intermittently. By March 1 sufficient rock will probably be coming from the drifts to keep one head operating continuously.

Experimentation with flotation practice continues. Quincy's average yield per ton in the future will probably depend on the lowest grade of commercial rock. This will permit capacity tonnage in the stamp mill, with minimum costs, and conserve the life of the mine.

Two Butte Companies Strike New Ore

East Butte Mining has encountered its No. 45 vein on the 2,200 level, about 300 ft. south of the shaft, at its mine in the Butte district. The vein is 6 ft. wide and assays 4 per cent copper. A crosscut is being driven on the 2,600 level, north of the shaft, to tap five veins which were mined above.

In a raise from the 250 level, west of the shaft, Ardsley Butte Extension Mining has encountered high-grade silver ore, a few feet above the level. The company's property adjoins on the east that of the Ardsley Butte Mines Corporation, in the southwest part of the Butte district.

Re-establishment of North Butte Receivership Denied

Appeal for re-establishment of receivers of the North Butte Mining Company, heard in San Francisco on Feb. 4, was denied and within a few days the property of the company in the Butte district will be returned to its officers. According to Paul A. Gow, president and general manager, the two mines of the company will start operations in the near future, so as to take advantage of the present high price of copper. The company will employ about 2,000 men.

Granada Rouyn to Build Six-Mile Tramway

PLANS are being prepared for the construction of a six-mile cable tramway at the Granada Rouyn property, in the Rouyn district, Quebec, according to R. C. Gamble, president of the company. Development work on the 500 and 625 levels of the property has been favorable. No. 2 vein, which had given indefinite results, is now showing up well. Ore carries chiefly gold.

Mayflower-Old Colony Finds No Ore in Amygdaloid Bed

Mayflower-Old Colony has cut through a wide amygdaloid bed, at its properties in the Michigan copper district, without encountering any copper. The lode has favorable characteristics, containing minerals usually associated with copper, but copper is absent. It is possible the bed may be opened later by drifting. The crosscut, which is being driven from the 1,700 level of the shaft, now is in more than 4,300 ft. and has approximately 1,000 ft. yet to go.

Butte Manganese Plant Again in Operation

Domestic Manganese & Development Company, at Butte, Mont., which had closed its plant for rearrangement and for installation of additional equipment, lit its fires on Feb. 9 and was expected to start roasting "pink" manganese ores from the Butte Copper & Zinc Company about Feb. 16. Baffles have been installed to lessen flue losses and the capacity of the plant has been increased from 230 to 330 tons per day. A new apparatus for breaking the roasted ore that gathers in bunches in the furnace has been added and storage bins have been rebuilt so as to lessen labor in loading and unloading.

Marian Mining Applies for Permit to Build Power Plants

Marian Mining, of Alamosa, Colo., has made application for permission to erect a hydro-electric plant of 175 hp., on the Alamosa River in Conejos County, and another plant of 240 hp., on the Sanse River in Rio Grande County. The current generated would be used in mine work.

Phelps Dodge and C. & A. Settle in Carson Suit

Phelps Dodge Corporation and the Calumet & Arizona Mining Company are reported to have made a settlement with the Carson Investment Company for infringement of the Carson patents. Licenses for the use of the Carson patents have also been obtained.

Much Activity in Central Arizona Mining District

EXTENSIVE exploration and development work is being done at several points in the area between Superior and Miami, Ariz. Magma Copper has made preparations to sink a 3,000-ft. shaft at a point about three miles northeast of Superior on the Miami-Superior highway. Northeast of and adjacent to the Magma property the E. J. Longyear Exploration Company has contracted to diamond drill 1,500 acres for a group of Duluth men. W. E. Smith, of Duluth, is the local representative of the group and Hugh N. Roberts is engineer. G. Townsend Harley is geologist.

E. Schaaf Regelman, of Regal Asbestos, and Walter RuKeyser are heading a company which is developing the Battallieur and Berry claims, southwest of the Pinto Valley company's property. They are reported to have discovered a vein of ore, 55 ft. long, which averages 5 per cent copper. About 25 tons daily are being shipped to the Magma smelter by truck. At this property 25 men are employed. The ore is oxide and the company is planning to erect a 150-ton leaching plant. Gordon Kyner is superintendent. Los Angeles interests are preparing to reopen the Silver King Extension property which is situated north of the Magma property.

Three Tri-State Properties Change Ownership

THE Paul Revere Mining Company, composed of Baxter Springs, Kan., mine operators, has been incorporated for $50,000 to take over the Homestake mine of Federal Mining & Smelting, west of Baxter Springs, in the Tri-State district. Dr. A. G. Hull, owner of Rialto Mining, has purchased the Staton land, consisting of 200 acres, in the heart of the Picher section of the district, from Mrs. Sarah Corbett. The tract has been one of the most productive tracts in the district and is still being mined by Rialto, L. & G. Mining, Domada Mining and Consolidated Lead & Zinc.

Fred and Allison Childress have purchased the Dumarks mine from M. G. West and associates. The property was formerly owned by the Vinegar Hill Zinc Company.

Basin Montana Completes Unwatering Winze

Basin Montana Tunnel Company has unwatered its winze, from the south tunnel, at its property in the Basin district, and is cleaning it out preparatory to mining. The winze is 200 ft. below the tunnel level and contains a vein 18 ft. wide. A lead-covered cable is being strung in the tunnel and an electric hoist is being installed at the collar of the winze.

The trail to the Monarch mine, near Field, B. C.

Will Construct Cable Tramway at Monarch Mines

A CABLE tramway will be built to connect the properties of the new company that will be formed by Mining Corporation of Canada and Goldfield Consolidated to operate the Monarch and Kicking Horse properties, at Field, B. C., with the new concentrator which will be built there, as stated in the Toronto letter in the Feb. 9 issue.

Some idea of the difficulties with which the original development work had to be carried on will be conveyed by the accompanying photograph, which we have been able to reproduce through the courtesy of the British Columbia Bureau of Mines. It shows the trail to the Monarch—partly covered by snow sheds—around the side of the mountain to the original adit into the mine. From the trail to the Kicking Horse River is a sheer drop of 700 ft. These properties were acquired by A. B. Trites, who had an important part in the development of the Premier mine, in the Portland Canal district. He turned them over, together with the Giant mine, in the same district, to George Wingfield, Nevada mine operator, and associates. F. R. Eichelberger, of San Francisco, was in charge of development.

After a thorough exploration, the Giant property was dropped, but the development of the other properties was vigorously continued. Three orebodies have been developed. The West Monarch orebody has been exposed for a length of 700 ft. and a width of 125 ft., and 225,000 tons, estimated to average 15 per cent lead, 12 per cent zinc, and 1.9 oz. of silver, has been developed. The limits of the East Monarch orebody have not been defined, but it has been exposed for a length of 140 ft., with the face of the drift in ore; a width of 65 ft., and a thickness of 23 ft. This ore is estimated to average about the same as the West Monarch. On the Kicking Horse property, 50,000 tons have an indicated value of 3 oz. of silver to the ton, 5 per cent lead, and 15 per cent zinc.

Work on the construction of the 300-ton mill and the cable tramway will be started as soon as weather conditions permit. The properties are near the Kicking Horse tunnel on the main line of the Canadian Pacific Railway. The Monarch was discovered at the time of the construction of the railroad. According to the terms of the option, Goldfield Consolidated will retain a 65 per cent interest and Mining Corporation will obtain the remainder of the 2,000,000 shares issued. The company will be capitalized at 3,000,000 shares of no par value.

U. of Washington Mining Courses Have Large Attendance

REGISTRATION of 120 persons and an average attendance of 50 marked the sessions of the mining institute of the College of Mines, University of Washington, held at Seattle during the week of Jan. 21 to 26. In addition to those registered for the courses given in the daytime, many others attended the illustrated lectures in the evenings. The renewed activity in mining was reflected by the large attendance and by the interest shown in the various programs of the institute. Mining men and prospectors representing every phase of the industry, business and professional men who make contact with mining, and a scattering of persons who wished to hear special subjects attended the courses. It was noticeable that a large number of men came from outside Seattle to attend the meetings.

The program consisted of a series of lectures given by members of the faculty of the College of Mines and by outside engineers who presented subjects covered by their particular fields of interest. Laboratory demonstrations, a program of motion pictures, a trip to the Tacoma smelter, a luncheon given by the students' mining society, and a joint session with the North Pacific Section of the A.I.M.E. supplemented the formal lectures.

The special speakers and the subjects of their addresses follow:

George Watkin Evans, consulting engineer, Seattle, "The Coal Fields of the Pacific Slope."

A. H. Richards, manager of the Tacoma smelter, "The Purchasing of Ores, and the Metallurgical Processes Employed at the Tacoma Smelter."

Dale L. Pitt, manager of the Premier mine, British Columbia, "Mining From the Operator's Standpoint."

Robert T. Banks, of the Sullivan Machinery Company, Spokane, "Diamond Drilling for Prospecting and for Oil Production."

Dr. L. B. Slichter, geophysicist, Physical Exploration Corporation, Madison, Wis., "Methods of Electrical Prospecting."

Ward Royce, of the Ingersoll-Rand Company, Seattle, "Equipment for a Small Mine."

R. E. Murphy, of the Du Pont Company, Seattle, "The Use of Explosives in Mining Operations."

W. D. Shannon, Northwest Manager, Stone & Webster Corporation, Seattle, "Steam-Generated Power versus Hydro-Electric Power Development."

Charles L. Bretland, assayer U. S. Assay Office, Seattle, "The Assay and Purchase of Gold Bullion."

R. P. Leonard, of the Gardner-Denver Company, Seattle, "Rock Drilling."

Dr. H. F. Yancey, Northwest Experiment Station, U. S. Bureau of Mines, "The Work of the U. S. Bureau of Mines."

John Schoning, foreman miner, U. S. Bureau of Mines, "First-aid and Rescue Methods in Mining."

Dean Milnor Roberts, "Metal Mining Methods and Costs." "Ore Dressing." "The Mineral Resources of the Pacific Northwest."

Professor Joseph Daniels, "Recent Developments in Low Temperature Carbonization Processes and Improved Methods of Utilization of Coal." "Iron Ore Resources of the Pacific Northwest."

Professor C. R. Corey, "Metallurgy of the Common Metals." "The Significance of Metallography in Metallurgy."

Professor Hewitt Wilson, "The Origin, Occurrence, and Properties of Clays and Other Non-Metallic Ceramic Materials." "The Testing of Clays and Clay Products."

Dean Henry Landes, "Geological Aspects of Prospecting for Coal."

Professor George E. Goodspeed, "Petrology as Applied to Mining."

Professor J. Grattan O'Bryan, "The Significance of Recent Decisions on Leasing of Government Oil Lands."

Butte Southern Completes Installation of New Equipment

Butte Southern Mines, operating the Metz group of claims in the southwest part of the Butte district, has completed the installation of a 600 cu.-ft. Ingersoll-Rand compressor, driven by a 100-hp. Westinghouse motor, and has also installed a 75-hp. Ottumwa electric hoist. The property, which carries silver-lead ore, is opened by a 120-ft. shaft on the Virgo claim, this shaft having been unwatered, enlarged and retimbered to the 60-ft. point by Butte Southern Mines.

A.I.M.E. Opens 137th General Meeting in New York

Weather Is Balmy on First Two Days—Technical Sessions Are as Diversified and Interesting as Usual—Banquet to Be Last Held at the Waldorf-Astoria—Absence of President-Elect Hoover Is Regretted

NEW YORK exhibited its balmiest early springtime weather for the benefit of the engineers attending the opening days of the 137th general meeting of the American Institute of Mining and Metallurgical Engineers, Feb. 18 to 22. The snow that has interfered with the convenience of travel in other years has been absent throughout the winter. Indoors, the usual attractive and diversified technical programs had been arranged in the Engineering Societies Building, and the social events were of more than ordinary interest. It was the last appearance of the engineers at the Waldorf-Astoria for a banquet, for that famous hostelry is soon to be torn down; and the selection of the Astor for the smoker, with the accompanying entertainment offered, was a happy one. Unfortunately, the profession's most distinguished member and the country's most distinguished citizen could not be present, but that was hardly expected in view of the fact that March 4 was only two weeks away.

The technical programs, which lasted from Monday morning until Thursday evening, included papers on iron and steel, coal and coal products, mine ventilation, ground movement and subsidence, mining methods, mining geology, non-metallic minerals, geophysical methods, milling methods, non-ferrous metallurgy, metallography, engineering education, petroleum, and production control. Only that part of the program occurring on the first three days can be covered here. The papers on mining geology and geophysics, together with a report on the banquet and the trip up to West Point, scheduled for Washington's birthday, will be covered in next week's issue.

Results of Potash Exploration Described

Dr. Oliver Bowles presided at the opening session on non-metallic minerals on Monday morning. C. W. Ryan, of Lynchburg, Va., presented a paper in which he sketched the geology of the soapstone occurrences in the Piedmont section of Virginia, in the southern part of Nelson County, and described the methods of prospecting, quarrying, and milling employed. He was followed by W. M. Weigel, of the Missouri Pacific Railway, who discussed the barite industry of Missouri, which is one of the two principal producing regions in the United States.

The results of the government's exploration work for potash in Texas and New Mexico were set forth in a noteworthy paper by G. R. Mansfield and W. B. Lang, of the U. S. Geological

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Survey. The third year of government exploration for potash by the Survey and the U. S. Bureau of Mines under the authorization of the act approved June 25, 1926, was drawing to a close, the authors said. Results to date were thought to be sufficiently interesting and satisfactory to justify a preliminary account.

The general geologic similarity of the Permian basin of Texas and New Mexico to the potash field of Germany had long ago suggested the possibility of the presence of potash salts somewhere in that basin, but petroleum exploration was then making little headway and the necessary data could not be obtained. The first direct evidence of the presence of potash was obtained in 1912. In 1915-17 the Survey had drilled a well near Amarillo without success, the authors said. Nevertheless, an observer had been kept in the field, at first in connection with the Texas Bureau of Economic Geology, but since 1922 by the Survey alone, to secure data and samples from oil and gas tests. Since the discovery of oil in Reagan County in 1923, exploration by drilling had been rapidly extended to many parts of western Texas and southeastern New Mexico. Identification of the potash-bearing mineral, polyhalite, was announced by the Survey in 1921, the material having come from cuttings from the Bryant well in Midland County and the Burns well in Dawson County, Tex. Successive discoveries had aroused widespread interest in potash exploration which culminated in the action by Congress already noted.

So far as known, the potash-bearing salts most likely to have commercial importance are confined to the southern portion of the Permian salt basin, being found in an area of about 40,000 square miles in southeastern New Mexico and the panhandle of Texas. The formations with which they are more directly associated are concealed throughout the basin. In Germany the potash-bearing salts are largely associated with salt domes, and salt domes have recently been discovered in Alsace, but in western Texas and southeastern New Mexico none have thus far been discovered. Salt domes, however, are important structural features of the Gulf Coastal region of Louisiana and Texas, and one of these in Matagorda County, Tex., had yielded potash salts at a depth of 4,800 ft., it was stated.

In at least two of the ten localities drilled under government auspices beds of polyhalite thick enough and rich enough to suggest commercial exploitation had been discovered, and two other localities may be considered as having commercial possibilities, Messrs. Mansfield and Lang reported. In a test made about 28 miles southeast of Carlsbad a bed of polyhalite 8 ft. 10 in. thick and averaging 11.08 per cent of K_2O in the sample, equivalent to 18.25 per cent in the soluble salts, was found at a depth of about 1,466 ft. If other associated beds were considered, this interval would include 15½ ft. of beds, containing 8.84 per cent of K_2O in the sample, equivalent to 13.39 per cent in the soluble salts. At a depth of 1,935 to 1,945 ft., near Metz, in southwestern Ector County, Tex., two polyhalite beds having a combined thickness of 6 ft. 7 in. and together containing 12.86 per cent of K_2O in the sample, equivalent to 18.98 per cent in the soluble salts, were found. These beds are separated by a third bed of halite 2 ft. 10 in. thick. The two remaining localities of those referred to are in southwestern Upton County, near McCamey, and in northwestern Crockett County.

Polyhalite Only Potash Salt Found in Work in Texas

The only potash salt found in the government wells in Texas thus far is polyhalite. In New Mexico, the first two government wells encountered sylvite and carnallite and other soluble potash-bearing minerals in beds that were relatively rich but too thin to be of commercial interest.

Private exploration has been stimulated by the government and state activity. Among these companies are the Gypsy Oil Company, the American Potash Company (Kansas), the American Potash Company (Texas), and the American Potash Company (New Mexico).

As for the outlook, the authors state that sufficient supplies of potash salts have been demonstrated in the Permian, so that if production problems were

solved the United States could feel assured of freedom from foreign monopoly during any future national emergency, such as that in 1910, when existing American potash contracts were voided by German legislation, and again in 1915. However, since production from such sources can not spring up overnight on sudden demand, the authors state, it is highly desirable from the viewpoint of national welfare that the problems of potash production in this field be solved without undue delay and that commercial exploitation be started if practicable.

The mineralogy of the drill cores taken in the course of this work was discussed in a paper by W. T. Schaller and E. P. Henderson, which the former presented with the aid of lantern slides at the afternoon session. Mr. Weigel presided. G. F. Loughlin, of the Survey, in an illustrated talk on Indiana oölitic limestone, dealt with the relation of its natural features to its commercial grading. Two other papers were presented by title only. They were "Clay Mining for Quality," by H. E. Nold, and "The Occurrence of Bentonite in Southern Arkansas," by George C. Branner.

Non-Ferrous Metallurgy

The only session on non-ferrous metallurgy was held on Monday afternoon under the chairmanship of R. M. Roosevelt. "High Zinc Slags in Australia," a short paper by Philip S. Morse, was read by Felix E. Wormser. In discussing the paper, R. C. Canby spoke of his experiences with high alumina slags, and H. W. Hixon told of work in Mexico, at the smelter of the Teziutlan Copper Company, where at one time he fell into a settler and was blown out of the molten matte and slag with no permanent damage. G. C. Stone contributed a first hand account of the Port Pirie practice in 1918, and two written discussions of the paper were also offered.

The second paper, "Lead Alloys for Anodes in Electrolytic Production of Zinc of High Purity," by U. C. Tainton, A. G. Taylor, and H. P. Ehrlinger, was presented in abstract form by Mr. Tainton after some introductory remarks by F. E. Pierce. C. S. Witherell then asked if there were any solution of the zinc cathodes in the electrolyte, to which Mr. Tainton replied that there was substantially none, the power having been off for as much as three hours at times, with no resultant necessity of lifting the cathodes out of the acid. Professor H. R. Hanley asked about the electrode potentials with varying compositions of electrolyte, but on this subject Mr. Tainton had little data, although he stated that silicic acid made no appreciable difference compared with the glue formerly used. A large array of cast, rolled, and drawn products made from Sullivan electrolytic zinc was exhibited.

Professor H. R. Hanley then read his paper on "Formation of Insoluble Zinc Compounds During Roasting," written in association with Charles Y. Clayton and David Walsh. Mr. Tainton was

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naturally much interested in this subject, and asked if Professor Hanley had made any tests on the solubility of ferrites as affected by temperature. The Sullivan plant had been roasting marmatite ores, in which all the iron is combined with zinc. Three hours of treatment with 15 per cent acid was necessary to effect any considerable amount of solution and it was thought that it was due to the high furnace temperature. Professor Hanley said that he had made no specific tests on this subject. Mr. Tainton then said that he had found that the solubility of ferrite was a function of its magnetic susceptibility, the highly magnetic material at Kellogg being particularly difficult to dissolve. E. L. Jorgensen related his experience with copper ferrites, which Mr. Tainton said were much more easily soluble than zinc ferrites, and the solubility curve was much steeper with increase in acid strength. Mr. Roosevelt asked about cadmium ferrites, but no information was available except that cadmium solubility followed closely that of zinc. Professor Hanley stated that the Joplin ores contained 0.3 to 0.35 per cent of cadmium, which, after roasting to 675 deg. C., offered no particular difficulty in solution.

Holt-Dern Process at Cerro

"Blast Roasting at Cerro de Pasco" was the subject of a paper by Glenn A. Keep, presented by W. C. Smith. The Holt-Dern process has been a great success at Cerro in the last two or three years, extractions of 85 per cent of the silver being secured, whereas other processes were much less efficient. In the ensuing discussion, Mr. Tainton said that formerly it was thought that blast roasting produced highly insoluble ferrites, but that his experiments on St. Joe concentrate, Wedge roasted and sintered in Dwight & Lloyd machines, had shown that the product was very amenable. He ventured the opinion that the Holt-Dern furnace was a most efficient blast roaster and that there is a possibility of applying it to zinc roasting. The very low costs at Cerro were emphasized, but these were shown to be due in large part to low wage rates. Mr. Roosevelt pointed out that costs as high as $3.50@$4 per ton were not unusual in zinc roasting.

The last paper of the afternoon, by L. D. Anderson, on "Handling of Fine Ores and Concentrates in Salt Lake Valley Smelters," was read by E. H. Robie, F. F. Colcord presiding. In the discussion, C. M. Warner spoke of the lower blast pressures used at the Herculaneum furnaces, 26 to 28 oz. being formerly the rule. However, when he was visiting Kellogg recently, he found that only 20 oz. was used there and that the ore column had been cut to 8 ft. On instituting the same practice at Herculaneum he found that the furnaces would run 20 to 25 per cent faster. Describing the Herculaneum practice further, he said that hot sinter was not conveyed at Herculaneum but was dumped into railroad cars and taken to another place for crushing. Sampling of concentrates was performed with a 6-in. auger at several points over the cars, the samples extending to the bottom of the cars in order to get the proper proportion of the wettest material. Replying to a question from Mr. Colcord, he said that the Herculaneum furnaces averaged about 7 tons of charge per square foot of hearth area. About 90 per cent of the charge was sinter containing 55 per cent lead, and coke amounted to about 8 per cent on the charge. Messrs. Canby, Lloyd, Jorgensen, Stader, Hixon, and Hayward also contributed to the discussion, Professor Hayward stating that his laboratory work had indicated the advisability of a short ore column in lead blast furnaces, as well as large chunks of coke rather than small pieces.

Engineering Education

Need for a new viewpoint on the part of the public in regard to the mining industry was expressed forcibly by S. S. Wyer, consulting engineer, in his address, "Acquainting the High Schools With the Importance of the Mineral Industries," the first paper presented at the Monday afternoon session devoted to engineering education, at which E. A. Holbrook, dean of the school of engineering and mines, University of Pittsburgh, presided. Mining as a profession, if given a fact-facing study, should have an effective appeal for the high-school student, and in discussing this Mr. Wyer pointed out that the present civilization depends on fuel. Consequently, a sane utilization of energy-producing resources is essential to the progress of civilization. Mining, as a life work, he said, therefore offers a great challenge to the ability of a young man, and, if this challenge is properly presented, it should lead to a marked increase in the number of high-school graduates entering the mining schools of the country.

The next speaker, Frederick W. Bradley, president, Bunker Hill & Sullivan, and president-elect of the Institute, outlined what an operating company expects of the college graduate. The company desires, he said, a graduate who has a good grasp of fundamentals, who, with patience, tolerance, and without too much expense, can be developed into a loyal and trained

member of the company. He should have culture, be liberal in his views, and possess a good sense of sportsmanship. Student mining associations should receive the close interest of the Institute, Mr. Bradley said, for in this way, particularly, can mining be dignified with the student and pride in the profession be inculcated. Dr. C. H. Fulton, director, Missouri School of Mines and Metallurgy, presented the other side of the educational-industrial problem—that is, what the college expects of the operating companies in receiving and training its graduates. Rather than expecting anything, Dr. Fulton said humorously, the college hoped for considerable. Effective liaison between college and company personnel departments, a tendency to seek technical graduates at too low salaries, and the growth in competitive bidding for graduating students each year, are three factors, he said, that deserved consideration. The mining industry, he added, should offer opportunities that will attract the best young men. L. E. Young, vice-president, Pittsburgh Coal Company, and W. B. Plank, head of the mining department, Lafayette College, contributed additional information bearing on the problem.

In an interesting paper, C. E. Lawall, head of the mining engineering department, West Virginia University, outlined the mining courses introduced recently at several high schools in West Virginia at the suggestion of the University. Instructors for the courses are obtained from the science departments of the high schools, and these instructors attend mining extension classes offered by West Virginia University. Considerable instruction in first aid is a feature of the high-school mining course.

A report summarizing the results obtained in an educational study made by *Engineering and Mining Journal* was presented by H. D. Keiser, assistant editor.

Mining Practice at Miami and Andes Discussed

Two papers on copper-mining practice were presented at the joint meeting of the Mining Methods and the Ground Movement and Subsidence Committees on Monday afternoon. C. E. L. Arnold, of the Andes Copper Company's New York staff, read a paper prepared by I. L. Greninger, of Potrerillos, Chile, on "Mine Development and Underground Construction of Andes Copper Mining Company's Potrerillos Mine." Mr. Greninger's paper outlined the history of the mine, the geology of the ore deposit, the scope and nature of the exploration work; and the general mining plan, a form of undercut caving, was explained in detail. The other paper presented at this session was that of F. W. Maclennan, general manager, Miami Copper Company, entitled "Subsidence From Block Caving at Miami Mine, Arizona." The series of lantern slides and drawings, with a written description of the Miami ground-movement details accompanying Mr. Maclennan's paper, was prepared by E. V. Graybeal, mining engineer for Miami Copper Company at Miami, Ariz.

Three Papers on Milling Methods Presented and Discussed

Galen Clevenger presided at the Milling Methods Committee session on Monday afternoon. A paper on "Calculations in Ore Dressing," by W. Luyken and E. Bierbrauer, of the Kaiser Wilhelm Institut für Eisenforschung, Düsseldorf, Germany, was read by A. F. Taggart. C. R. Ince, of Columbia University, presented a paper on "A Study of Differential Flotation," an unfortunate title that seems somewhat confusing, serving to bring up again the selective vs. differential terminology question. Mr. Ince's paper described a laboratory investigation of Neihart, Mont., ore similar to that treated at the Timber Butte custom selective flotation plant at Butte, Mont. Mr. Ince's conclusions constitute in part a revision of the slime-coating theory of selective flotation phenomena recently advanced by Professor Taggart. Prof. A. M. Gaudin, of the University of Utah, contributed a written discussion of Mr. Ince's paper. A 75-page pamphlet, entitled "Experiments With Flotation Reagents," by A. F. Taggart, T. C. Taylor, and C. R. Ince, was presented in part by Professor Taggart. A feature of this paper that will undoubtedly prove of great value is a table of 492 flotation reagents, listing chemical names and compositions; solubility; flotation behavior—that is, whether as collectors or frothers in acid, neutral, and alkaline pulps; flotation classification—frother, collector, depresser; polar group characteristics; and the number of "insoluble" carbons contained. Professor Taggart pointed out that with the data contained in this table it becomes practicable to deduce, with a reasonable degree of accuracy, from the structure and solubility of a flotation reagent, what its effect in flotation will be. Difficulties in arriving at satisfactory definitions of collectors and frothers were recounted and the empirical definitions ultimately accepted were described in detail. Written discussions of this paper were contributed by Dr. R. E. Head, microscopist of the U. S. Bureau of Mines at Salt Lake City; Prof. A. M. Gaudin, and A. E. Anderson, of the University of Utah. The following papers were read by title only at this meeting, it being planned to present them in full at the San Francisco meeting next fall: "Copper in Cyanidation," and "Zinc in Cyanidation," by E. S. Leaver and J. A. Woolf; "Crushing and Grinding II—The Relation of Measured Surface of Crushed Quartz to Sieve Sizes," and "Crushing and Grinding III—Relation of Work Input to Surface Produced in Crushing Quartz," by John Gross and S. R. Zimmerley.

At the Milling Methods Committee dinner at the Engineers Club, on Monday evening, an informal discussion was indulged in of the work under way in the Salt Lake Valley by the U. S. Bureau of Mines with the co-operation of the mining and smelting companies, under the direction of Gross and Zimmerley. Some of the difficulties encountered in the work of evaluating grinding efficiency, measuring power requirements, and the complex related problems involved in this work were explained. The intention of the Institute to feature the milling program at the San Francisco meeting next fall also was touched upon.

The customary annual smoker was held this year at the Astor Hotel rather than at the Mecca Temple, as in recent years, and the consensus of opinion seemed to favor the change. Renewal of old acquaintances was, as usual, the feature of this meeting, though the rapt attention of the members was given to the entertainment offered by Dunninger, mind-reader extraordinary. A few of Mr. Dunninger's feats included the magical picking of thoughts held by various guests, literally out of thin air. Dr. George Otis Smith admitted holding the word "saltdome" in mind when confronted with it by the seer. The interest shown in this entertainment was a marked compliment to the choice of the Smoker Committee.

The Annual Business Meeting

Tuesday morning was devoted entirely to the annual business meeting of the Institute, but a comparatively small proportion of the membership was present. George Otis Smith, retiring president of the A.I.M.E., presided. A meeting in San Francisco on Oct. 7, 8 and 9 was announced, just before departure for the Japanese trip, and meetings will be held in Los Angeles and Spokane at about the same time. A protracted discussion of the proposed change in the by-laws regarding the admission of junior members and their transferral to regular membership followed, with no conclusions reached. A bronze bust of President-elect Hoover was then unveiled, this being the work of Mrs. W. D. Leys, of Yonkers, and presented to the Institute by C. A. Fisher, of Denver.

E. A. Sperry told of the plans for the Japanese trip next October, for which 210 reservations have already been made, and G. A. Roush described the work so far accomplished with the Museum of Peaceful Arts in New York City, now housed in the Scientific American Building on West 40th St., to which the members are invited. Dr. George Otis Smith invited members and guests attending the inauguration at Washington, to a reception and dance in the new building of the Interior Department at 9 p.m. on March 4.

The results of the recent election of officials of the A.I.M.E. for the coming year were next announced, Frederick W. Bradley being elected president with a total of 2,492 votes, several others receiving one vote each. H. A. Buehler and Edgar Rickard were elected vice-presidents, and the following directors were named: F. W. Paine, Harvey S. Mudd, Eugene McAuliffe, Erle V. Daveler, and William R. Wright.

A symposium on Production Control occupied the entire attention of the members on Tuesday afternoon. Carl Snyder delivered an excellent address on "Long-time Growth and the Factors in Its Variations," in which he brought out that the stability and evenness of the growth of trade are undreamt of in our business philosophies. The main body of production and trade, 80 per cent or more of the total, runs on from month to month with a stability not usually conceived. One index of this stability is bank debits, formerly referred to as bank clearings, a compilation of data from 140 cities, which goes up and down from week to week with astonishing regularity. Seasonal variations are well recognized. These debits increase about 4 per cent each year unless there are serious changes in the buying power of the dollar. The number of persons employed in trade and transportation varies in much the same way as do the data for production, though this increases about 3½ per cent from year to year instead of 4 per cent. The profit from no one industry can persist at abnormal levels, for it will then attract competition, with an ensuing reaction. Banking, currency, or credit conditions, said Mr. Snyder, are the most disturbing factors in industry.

Professor W. H. Hamilton, of Yale, then gave an equally interesting talk on "The Sherman Act and Production Control." A logical thing for producers to do, thought Professor Hamilton, was to decide on what the consuming demand was likely to be for a given article, and then to allocate production, but the chief obstacle to this was the Sherman Act. However, that only forbids "restraint of trade," and just what that means is for the courts to decide, as many different meanings have been read into this phrase. The so-called "rule of reason" was then mentioned, but one court has held that this rule does not apply in matters pertaining to the Sherman Act, if the possibility of non-competition exists. The "rule of possible evil" has been humorously suggested as a substitute. If there exists an opportunity to do wrong, any collusion is illegal according to this interpretation.

Professor Hamilton did not think that the Sherman Act was administratively effective, and suggested eight possible defenses. It should be repealed, in his view, and some other agency of control set up in its place. There should, of course, be *some* check. Industrial statesmanship is required to solve the problem. The matter of giving industry a free rein, and then having the government act as a policeman when wrong was done or suspected, was held undesirable.

James A. Veasey then presented a paper entitled "May the American Petroleum Industry Through Voluntary Action Control Its Production?" and the session wound up with a paper by D. F. Hewett on "Cycles in Metal Production." Mr. Hewett's paper was illustrated with several curves showing the production records of numerous camps, and he developed the need of some method of production control, drawing lessons from European practice in exploiting metal mines.

Mining Methods

A study of misfires at the four quarries and three mines of the Pittsburgh Limestone Company during the five-year period of 1924-1928 was the outstanding feature of the Wednesday morning session devoted to mining methods. The study was presented by A. W. Worthington, of the company, under the title, "Misfires, Their Causes, Remedies, and Treatment on Occurrence." In the operations considered, a total of 3,903,352 holes were fired and a total of 793 misfires occurred. Three methods of firing were used—namely, Cordeau, electric detonators, and cap and fuse. Of the total number of holes fired, 1,112 were fired with Cordeau, and of this number only one misfired. Electric detonation was used for 1,446,279 holes, 383 misfires occurring. Cap and fuse were employed in firing 2,455,961 holes, 409 of which misfired. For each of the three methods of firing, the number of holes fired per misfire were: Cordeau, 1,112; electric detonators, 3,780; and cap and fuse, 6,000. On a weighted average basis, these figures reveal that for the total of 793 misfires, the number of holes fired per misfire was 4,920.

Following the presentation of these statistics, Mr. Worthington discussed the causes of the misfires and the methods employed in dealing with them at the company's properties. Significant among his remarks on the latter point was the statement that during the five-year period considered, no accident occurred in the handling of misfires, and, moreover, no lost-time accident of this nature had occurred in the last ten years. Methods employed by the company in achieving such a record, he said, included the maintenance of a blasters' school, in addition to the usual accident-prevention work and safety measures commonly used. Monthly sessions of the blasters' school are held, and, in order that the meetings may continue to hold the interest of the workmen, technical representatives of explosive companies, state mining officials, and others are invited to speak to the group. Among features of the company's practice in reducing the number of misfires, Mr. Worthington mentioned the following:

1. Select intelligent and careful type of workmen, and provide good supervision.

2. Select explosives suitable for the purpose employed.

3. Inspect explosives frequently during their storage.

4. For certain purposes, avoid the use of explosives that have been in storage for a considerable period.

5. Maintain a record of each shot.

6. Have no rigid rule for treating misfires, but leave the problem in charge of a trained foreman who is familiar with the dangers of each of the several methods of treatment and who can be trusted to appeal for assistance in handling any difficult misfire problem.

7. Do not adopt any rule relative to misfires unless the rule is unquestionably necessary and will reach the source of trouble to be remedied.

In brief, the company outlines a practice in connection with misfires, but no rules are given, since it is believed that greater safety ensues if the blasting foreman, who has full knowledge of each individual case, determines the method to be employed. The entire supervising organization of the company, Mr. Worthington said, feels that the selection of the proper type of employee handling explosives, and his constant and careful education and supervision, are most important. Responsibility for the number of misfires, as well as accidents, in the use of explosives, he added, depends primarily on the operator and his employees, in the inspection of the materials used, and in the broadening of the organization's knowledge of the best blasting practices.

"Misfires in Bituminous Mining," by W. H. Forbes, was presented in his absence by S. P. Howell, who presided at the session. T. D. Thomas discussed "Misfires in Anthracite Mining."

Following the presentation of the aforementioned three papers, the remainder of the session was devoted to an animated discussion on the general subject of misfires. B. F. Tillson commented on the statistical phase of the problem; D. Harrington discussed the importance of education in reducing misfires; and R. V. Ageton referred to the important features of the shot tube employed in the Tri-State district.

Mine Ventilation

To provide opportunity for further consideration of the proposed mine-ventilation code for coal mines, which was discussed at the Wednesday morning session, the afternoon mine ventilation program was covered briefly. Subcommittee reports by D. Harrington, Dr. R. R. Sayers, and A. S. Richardson were not presented, and "Pressure Measurements in Fan Testing," a paper by W. S. Weeks, was read by title only. In the absence of O. A. Glaeser, his paper, "Mine Ventilation at the United Verde," was presented in abstract form by D. Harrington. The opinion that the United Verde is the best-ventilated metal mine in the United States was expressed by Mr. Harrington, who urged careful reading of the paper by all those interested in mine ventilation.

The principal paper presented at the session was, "Air Conditioning in Deep Mines," by R. W. Waterfill, of the Carrier Engineering Corporation. In discussing a subsurface cooling and conditioning plant, Mr. Waterfill pointed out that it must be reasonably small, safe in operation, and perform two major functions—namely, it must remove the heat from downcast air first before it enters the working levels, and it must find some means of discharging this heat outside the mine. He then described an air-conditioning system designed to accomplish this.

MARKET AND FINANCIAL NEWS

Lack of Aluminum Hampers Use by Germans in Place of Copper

By Dr. James Rubinfeld

Special Berlin Correspondent

GERMAN metal trade activities have slowed down. Financial uncertainties arising out of the reparation question seem to have a further unfavorable influence on the trend of developments in general. Of course, the price policies of the Brussels syndicate of copper are also militating against any appreciable expansion of the German copper manufacturers who seriously ponder the vexing problem of aluminum vs. copper. This item is thus far in the "egg state," and it has yet to be "hatched," because the entire aluminum output of Germany, including that of the Bitterfeld plant of the Metallgesellschaft and the chemical combine I. G. Farbenindustrie together, is but little more than 42,000 metric tons annually, whereas the yearly copper consumption amounts to no less than nine times this sum. At the present price of copper, 18¼c. per pound c.i.f. European harbors, and considering the relative weights of the two metals, copper costs from 20 to 50 per cent more than aluminum, when special adaptations and manufacturing charges are considered. The official import figures of the German metal trade for 1928 are compared with those for 1927 as follows:

German Metal Imports for 1928 and 1927 Compared, Including Alloys

	1928	1927
Aluminum	15,740	13,334
Antimony	3,374	3,375
Copper	315,407	325,682
Lead	148,936	.....
Nickel	4,502	3,775
Silver	16	16
Tin	13,633	15,936
Zinc	151,733	160,181

Imports of refined copper in 1928 totaled 226,983 metric tons, against 230,844 tons in 1927. Exports of refined copper were 21,796 tons in 1928 and 18,396 tons in 1927. The principal recipients of the exported copper were Czechoslovakia, Russia, and the city of Danzig. In this connection it should be realized that the smelting and refining of copper in Germany has advanced considerably in recent years, as was forecast by Dr. Alfred Merton in 1927.

According to output data gathered by the Metallgesellschaft, the smelter production of copper in 1928 was 58,597 tons and the refined output 102,758 tons. The same Metallgesellschaft of Frankfort-on-Main has managed to secure control of several small prospects, such as the Otavi mines, in southwest Africa. These ores are smelted by Katanga and the Norddeusche Affinerie, in Turkey. Recently this concern has taken a large interest in the North African phosphate rock development of the Compagnie Minière M'Zaita, which, however, is not only a producer of phosphates but owns also the Mines et Fonderies de Cuivre de Chagres. Copper deposits of the latter are to be developed with the help of mining experts of the Metallgesellschaft. The Metallgesellschaft participates in the Brussels syndicate and falls somewhat in line with its greater brother, the American Smelting & Refining Company, whose reported control of N'Changa Copper Mines created a tremendous sensation in German mining circles.

Germany produced 98,356 tons of zinc in the last year, as against 84,062 tons in 1927; and 104,839 tons of crude lead, against 96,075 tons in 1927. Thus it will be seen that the trend is toward increased domestic production of metals in Germany. On the other hand, the German zinc output is expected to receive a large setback from the international agreement of the Brussels zinc syndicate, so its coming decrease in production may be relatively larger than for other members of the syndicate.

This condition may hold for the Belgians also, with their record output achieved in 1928. In passing it may be mentioned that the Belgian Société Metallurgique de Boom, the Société Générale Union Chimique, Overpelt-Lommel, and the well-known Vieille Montagne have formed a new firm with a capital of 30 million francs for the development of entirely new processes in zinc metallurgy. Details of these processes are not yet known, but it is believed in some quarters that they resemble some of the more recent English processes. The Liége Vieille Montagne will soon increase its capital too, and this may serve for taking a hold in mining concessions and for new participations. Moreover, the whole Belgian system of metal producing and manufacturing seems ripe for some consolidations such as those already reported with Belgian industry in general under the influence of Brussels banking interests.

As a consequence of metal price control by producers, option dealings on the German Metal Exchange, which for some past time were quite important, have declined rapidly in the past year and amounted to only 38 per cent of the 1927 total. The decrease was greater in copper dealings.

The Belgian government has decided to bring out 150 million of francs in nickel coins of 5 francs apiece. Similar considerations are looming in other European countries. As for the great nickel merger of the International with Mond, some people are reckoning that the stock valuation of the new combine now exceeds by some 50 per cent that of the Witwatersrand and Eastern Rand mines together. Price stability of nickel metal will, it is hoped, be sustained, and if this is effected the consumption of the metal will grow apace in Europe, especially for automobile purposes.

The marked decline in platinum prices is being traced to growing uses of substitutes in the United States for luxury purposes, especially by palladium. But there are some signs that a price fall has been deliberately caused by such interests in Europe as would force the Soviet government to re-enter a production agreement. German experts—and in this particular field they are numerous—believe that the coming Transvaal platinum production is still far from a commercial stage.

According to Zurich advices a firm named "S. A. d'Aluminium Coire" has been founded at Chur (Switzerland) with Mr. Davis, of Pittsburgh, as vice-president. The object of the firm is said to be the acquisition of industrial and trading undertakings. Further details are lacking.

Alaska Juneau Gold Mining Company's production for 1928 was the largest in the history of the company, amounting to $3,200,000, on which the operating profit is estimated at $920,000. The company's production exceeded 50 per cent of the total Alaskan output. It exceeded its 1927 production by $820,000. The tonnage mined was 3,700,000, as compared with 4,263,000 tons for the previous year. Of this year's total 1,800,000 tons was milled. Higher-grade ore featured the year's operations. The company has increased its payroll from 600 to 650 men. Operating expenses for 1928 amounted to $1,700,000, of which $1,250,000 was in wages.

Copper Consumption by Electrical Industry Increases

THE A.B.M.S. estimates consumption of copper in three of the important copper-requiring industries of the United States in the fourth quarter of 1928, and in previous quarters as follows, in tons of 2,000 lb.:

To the estimated domestic consumption in these three industries is added the report of manufactures for export, which includes plate and sheet, rods and wire, and all other primary fabrications of copper and brass for export. The sum of the quarterly estimates of the use of copper in automobiles usually underruns the annual, revised estimate.

1927	Electric Manufactures	Automobiles	Buildings	Manufactures for Export
First quarter	45,500	24,100	11,300	12,800
Second quarter	49,000	28,300	10,700	15,600
Third quarter	48,000	24,600	12,800	14,200
Fourth quarter	54,000	17,600	11,300	13,500
Totals	196,500	94,600	46,100	56,100
1928				
First quarter	45,000	26,600	11,400	16,400
Second quarter	54,500	32,000	12,100	16,200
Third quarter	54,000	32,000	15,500	16,200
Fourth quarter	59,200	22,000	12,900	17,000
Totals	212,700	112,600	51,900	65,800

London Financial News

By W. A. Doman
Special London Correspondent

LONDON, Feb. 5, 1929—Last week I mentioned that the N'Changa Copper Mines, Ltd., was, under its new scheme of financing, being virtually disposed of to American interests. This rumor, or statement, apparently did not meet with official approval, for a kind of apologia or criticism has appeared in *The Financial News*. A high price is suggested for the shares, up to £10 in fact, in time, but the value of the property, it is admitted, is still in part contingent. As regards American capitalists' obtaining control, the question appears to be merely one of price, and "creating industries and selling them at a profit seems not so different from manufacturing goods for a similar purpose."

Quite a sensational turn in events is now taking place, for a very powerful group, consisting of the Rhodesian Anglo-American, Ltd., British South Africa Company, British Metal Corporation, Johannesburg Consolidated Investment, Rio Tinto, and Union Corporation, has made a counter bid for the property. The new terms are that this group will subscribe for 50,000 shares in N'Changa Copper Mines at £2 10s. per share, and will guarantee, free of any commission, the subscription of 150,000 similar shares at £2 10s. per share, the 150,000 shares to be offered to N'Changa shareholders pro rata to their present holdings. The offer is made on the following conditions:

1. In any further issues of shares by N'Changa, the new group will have the right to subscribe 25 per cent of such shares and will guarantee, free of any commission, the subscription of the remaining 75 per cent, which must be offered to N'Changa shareholders.

2. N'Changa Copper Mines to acquire from Rhodesia Congo Border Concession the rights over 30,000 acres referred to for 200,000 fully paid shares of £1 each in N'Changa Company. Comparing this offer with the one by the A. S. & R. it is claimed that the N'Changa Copper will be better and more cheaply financed; there will be no share manipulation, and the property will remain, as Rhodesia and its minerals are always expected to remain, in British hands. A somewhat similar offer has been made by the new group to the Rhodesian Congo Border Concession, Ltd. Naturally, the new group would require representation on the boards of the N'Changa and Rhodesian Congo Border companies. It is reported that A. S. & R. has amended its offer, but I cannot confirm this assertion.

In connection with what I have previously stated, that it was believed J. P. B. Webster was on the Continent negotiating for the return of the Russian concessions of the Russo-Asiatic, the following notice, issued yesterday, is interesting: "Of late, reports have appeared in the press to the effect that the Russo-Asiatic was completing negotiations with the Soviet government for the return of the Russo-Asiatic properties, and with Harriman & Company, and Guggenheim & Company, of New York, for the financing of the concession. Though it is quite true that discussions have taken place and are taking place with the Soviet government to find a basis for a concession agreement, such discussions and negotiations have continued now for more than nine years without any results. In view, however, of past experience, it is impossible for anyone to say whether the discussions which are taking place with the Soviet government will this time come to a satisfactory conclusion.

"Discussions and negotiations of a tentative nature have taken place with Messrs. Harriman and Messrs. Guggenheim regarding the financing of the Russo-Asiatic concession, but to make any statement as to the possible outcome of such discussions would be premature, as such an agreement must be dependent always on the terms on which the Russo-Asiatic concession is obtained from the Soviet government."

Utah Copper Made Record Earnings and Output in Fourth Quarter

THE operating statement of Utah Copper Company for the fourth quarter of 1928 reveals an increase in copper production amounting to nearly 20 per cent over that for the third quarter, and an increase of 40 per cent in net income.

The total net production of copper from all sources for the quarter is shown below, in comparison with the output for the three preceding quarters of the year:

1928	Net Pounds Copper Produced	Average Monthly Production
Fourth quarter	85,911,474	28,637,158
Third quarter	71,716,464	23,905,488
Second quarter	60,591,239	20,197,080
First quarter	55,604,174	18,534,725

The average cost per pound of net copper produced, including depreciation of plant and equipment and all fixed and general expenses and after crediting gold, silver and miscellaneous earnings, was 5.6 cents, as compared with 6.1 cents for the preceding quarter, computed on the same basis. This is the lowest cost ever recorded by Utah, and probably the lowest ever recorded by any primary copper mine.

During the quarter the Arthur Plant treated 2,591,500 dry tons of ore and the Magna Plant 2,822,800 dry tons, a total for both plants of 5,414,300 tons. The daily tonnage for both plants is 58,850 tons as compared with 46,400 tons in the third quarter.

The average grade of ore treated was 1.02 per cent copper and the average mill recovery was 80.03 per cent of that contained in the ore, as compared with 0.99 per cent copper content and 88.89 per cent recovery, respectively, for the previous quarter. Though not officially stated, the decrease in metallurgical, efficiency undoubtedly resulted from the large increase in tonnage milled which was not accompanied by a proportionate increase in grinding equipment.

The accompanying table shows the financial results of operations for the four quarters of 1928 as compared with the previous quarters of the year.

Financial Results of Operations

	Fourth Quarter	Third Quarter	Second Quarter	First Quarter
Net profit from copper production	$8,256,227	$5,871,357	$4,284,505	$3,401,720
Miscellaneous income, including gold and silver	1,001,370	884,670	680,345	566,094
Income from investments	1,181,179	832,631	782,631	857,631
Total income	$10,438,777	$7,588,659	$5,747,482	$4,825,446
Depreciation	260,299	335,405	312,160	309,226
To surplus	$10,178,477	$7,253,253	$5,435,321	$4,516,220

The Market Report

Lead Continues Active; Price Marked Up

Copper and Zinc in Better Demand Than Last Week, and Quicksilver Prices Are Advanced

New York, Feb. 20, 1929—The preponderance of news in the non-ferrous metal markets this week is bullish, with continued strength in lead a feature. Demand for that metal has been excellent, and prices have been advanced another 10 points. Copper and zinc are unchanged, at 18c. and 6.35c. respectively, but more than twice as much has been sold as was booked in the preceding week. Silver and tin are also substantially unchanged in price. Foreign quicksilver prices are reported advanced by American dealers.

Daily Prices of Metals

Feb.	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
14	17.775	49.75	6.85@6.90	6.725@6.75	6.35
15	17.775	49.625	6.85	6.75	6.35
16	17.775	49.625	6.85@6.90	6.75	6.35
18	17.775	49.125	6.85	6.75	6.35
19	17.775	49.25	6.95	6.85	6.35
20	17.775	49.125	6.95	6.825@6.875	6.35
	17.775	49.417	6.892	6.781	6.350

Average prices for calendar week ending Feb. 16, 1929, are: Copper, 17.775; Straits tin, 49.650; N. Y. lead, 6.860; St. Louis lead, 6.743; zinc, 6.350; and silver, 55.925.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary form of wire bars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up, depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Feb.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
14	76 1/2	77	83 1/2	224 1/4	225 3/4	22 13/16	22 13/16	26 3/16	26 3/16
15	76 3/8	77 1/8	83 1/2	224	224 3/4	22 7/8	23 1/16	26 1/8	26 1/4
18	76 3/16	76 7/8	83 1/2	220 3/4	221 1/2	23 1/8	23 3/16	26 3/16	26 1/4
19	76 1/4	77 3/16	83 1/2	223	223 3/4	23 3/16	23 3/16	26 1/16	26 3/16
20	76 13/16	77 1/2	83 1/2	221 1/2	222 3/4	23 5/16	23 5/16	26 1/8	26 5/16

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Feb.	Sterling Exchange "Checks"	Silver		Gold London	Feb.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
14	4.84 7/8	56	25 3/4	84s11 1/2d	18	4.84 1/4	55 3/4	25 1/8	84s11 1/2d
15	4.84 15/16	55 7/8	25 3/4	84s11 1/2d	19	4.84 1/4	56	25 7/8	84s10 3/4d
16	4.84 7/8	55 3/8	25 1/8	.....	20	4.84 1/4	55 7/8	25 13/16	84s11 1/4d

Average, 55.854

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command three-eighths cent premium.

Copper Continues Firm

The copper market has not been active, but the custom smelters, and some others as well, have done a satisfactory business at unchanged prices of 18c. per pound delivered in the East, and 18 1/8c. in the Middle West. Wire mills have been conspicuously in the market. Three-quarters of the copper sold has been for May shipment, though a call for June is beginning to be made, and over a thousand tons was sold this week for that position. On the other hand, several lots of February and March copper have been sold, even to the larger buyers supposedly well provided for. There are certainly no signs that fabricators have overbought, though it is possible that the ultimate consumers have purchased more liberally than they would have done if the market had not been advancing. A firm copper market seems reasonably well assured for some time to come.

The foreign demand has been quiet, though registering some improvement in the last two or three days. The price continues at 18 1/4c. per pound, c.i.f. Foreign consumers are not so well covered as are the domestic buyers, and orderly buying is being urged.

Refinery stocks may show a slight decrease at the end of February. Reports that Braden production will now get back to normal, with settlement of the tailing disposal difficulties, are held to be unjustified, as it will be some time yet before former production is reached.

Lead at 6.95c.

Excellent consuming demand continues to feature the domestic lead markets. On Feb. 19 the American Smelting & Refining Company advanced its contract price to 6.95c. from 6.85c. per pound, an increase that one or two sellers had anticipated as early as last Thursday by taking orders at premiums up to $3 per ton on good-sized lots over the 6.85c. contract price level.

Prices of lead on the London Metal Exchange have shown steady improvement since the recession of last Wednesday. However, the latest advance in New York price was occasioned more by the strong position of the important American producers than by any marked strength in the London quotations. Today's prices in the two markets are very close to the foreign bullion import parity point. Battery and cable manufacturers have been well represented on sellers' books. An unusual demand for forward delivery is reported by sellers, several of whom are asking and getting premiums for April delivery.

Zinc Still 6.35c.

The increase in the price of concentrates to $41 has so far had no effect in advancing zinc prices, but it does seem to have stimulated demand to some extent. Several good lots have been sold to galvanizers, largely for forward shipment, as far ahead as July having been in demand. High-Grade is quoted

at 7¾c. delivered in the East for odd lots, though 7.35c. represents the contract basis.

The January statistics, released last week, follow, in tons of 2,000 lb.:

Stock, Jan. 1	45,441
Produced	49,709
Shipped	49,732
Stock, Jan. 31	45,418
Shipped from plant for export	2,055
Metal sold but not delivered, Jan. 31	45,725
Total retort capacity, Jan. 31	116,136
Average number retorts operating	63,314

Tin a Trifle Easier

Tin continues the even tenor of its stabilized market behavior. Quotations are a trifle lower than a week ago, caused by the failure of the London "bulls" to support the market with their customary celerity.

Silver Low and Steady

The opening of the New Year in China did not bring support to the silver market. On the contrary, prices fell on the 16th to new low levels. India appeared as a moderate buyer at the lower price, and better buying by China banks caused a rally of ⅜c. from the low. The price again eased ¼c., but appears fairly steady at the close.

Mexican Dollars (Old Mexican pesos): Feb. 14th, 42¼c.; 15th, 42⅛c.; 16th and 18th, 42c.; 19th, 42¼c.; 20th, 42⅛c.

Foreign Exchange

Closing cable quotations on Tuesday, Feb. 19, were: Francs, 3.90½c.; lire, 5.24c.; and marks, 23.74c. Canadian dollars, 35/64 per cent discount.

Other Metals

Quotations cover large wholesale lots unless otherwise specified

ALUMINUM—Per lb., 99 per cent plus grades, price of leading interest, 24.30c. Outside market, 99 per cent plus, 24.30c.; 98-99 per cent, 23.90c.

ANTIMONY—Per lb., duty paid, New York: Chinese brands, 9½@9⅝c. per lb. for all positions. Cookson's "C" grade, spot, 14¼c.

BISMUTH—Per lb., New York, in ton lots, $1.70. Smaller lots, $1.85 and up.

CADMIUM — Per lb., New York: 85@95c. Active demand.

IRIDIUM—Per oz., $260@$265 for 98 @99 per cent sponge and powder.

NICKEL—Per lb. ingot, 35c.; shot, 36c.; electrolytic, 35c. (99.9 per cent grade) for single lots of spot metal.

PALLADIUM — Per oz., $38@$40. Small lots bring up to $50. Nominal.

PLATINUM—Official price quoted by the leading interest on small miscellaneous orders for refined metal, per oz., $70. Transactions between dealers and refiners in the outside market are commonly reported at several dollars less.

QUICKSILVER — Per 76-lb. flask. $120@$121 cash. Small lots command the usual premiums. Dealers handling foreign quicksilver have advanced prices to $122, but actual sales reported are nearer $120.

Prices of Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Osmium, Radium, Rhodium, Ruthenium, Selenium, Tantalum, Tellurium, Thallium, Tungsten, and Zirconium are unchanged from the issue of Feb. 9.

Metallic Ores

TUNGSTEN ORE—Per unit of WO_3, N. Y.: wolframite, $11.75@$12; Western scheelite, $12.50.

Chrome, Iron, Manganese, Tantalum, Titanium, Vanadium, and Zircon ores are unchanged from quotations in the Feb. 9. issue.

Lead and Zinc Ore Higher

Joplin, Mo., Feb. 16, 1929

Blende	Per Ton
High	$43.90
Premium blende, basis 60 per cent zinc	$41.00@ 42.00
Prime Western, basis 60 per cent zinc	40.00@ 41.00
Fines and slimes, 60 per cent zinc	36.00@ 39.00
Average settling price, all blende	39.73
Galena	
High	$93.20
Basis 80 per cent lead	92.50
Average settling price, all galena	88.95

Shipments for the week: Blende, 11,739; lead, 1,486 tons. Value, all ores the week, $598,530.

The price of lead concentrates has been advanced $2.50 per ton, with offerings for the week on a basis of $92.50 per ton of 80 per cent lead. This is the highest price paid since April 9, 1927, when a like basis prevailed.

The price of zinc concentrates has been advanced $1 per ton on all grades, the first change in the price of this ore since the week ending May 12, 1928, the price remaining unchanged 38 consecutive weeks. A few exceptions were recorded where $1 additional was added for lead-free ore.

Thawing ground retarded hauling this week, roads becoming so soft the last two days as to make long hauls impossible.

Platteville, Wis., Feb. 16, 1929

Zinc Blende	Per Ton
Blende, basis 60 per cent	$43.75
Lead Ore	
Lead, basis 80 per cent	$92.50

Shipments for the week: Blende, 673 tons; lead, 80 tons. Shipments for the year: Blende, 4,225 tons; lead, 240 tons. Shipments for the week to separating plants, 2,150 tons blende.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Silica, Spodumene, Sulphur, Talc, and Tripoli are unchanged from prices in the Feb. 9 issue.

Metallic Compounds

ARSENIOUS OXIDE (White Arsenic) Per lb., 4c. Several carloads sold this week but most producers find the market quiet.

Antimony Oxide, Copper Sulphate, Calcium Molybdate, Sodium Sulphate (Salt Cake), Sodium Nitrate, and Zinc Oxide are unchanged from prices in the Feb. 9 issue.

Alloys

FERROMANGANESE—Per long ton, domestic and foreign, f.o.b. furnace or duty paid, port of entry, $105. Spiegeleisen, 19@21 per cent, $33@$34 f.o.b. furnace.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, $1.04@$1.10,

NICKEL SILVER—Price advanced to 33c. per lb. for 18 per cent Grade A sheets effective Feb. 7.

YELLOW (MUNTZ) METAL—Price for dimension sheets advanced to 23½c. per. lb.; and for rods to 20½c. per lb., both effective Feb. 7.

Ferrocerium, Ferrochrome, Ferromolybdenum, Ferrophosphorus, Ferrosilicon, Ferrotitanium, and Ferrovanadium are unchanged from prices in the Feb. 9 issue.

Rolled Metals

COPPER—Price for sheets, hot rolled, advanced to 27⅜c. per lb.; and for wire to 19⅞c. per lb., both effective Feb. 7.

LEAD SHEETS—Full-rolled sheets 10½c. per lb.; clipped sheets 10¾c. per lb.

Monel Metal, Nickel, and Zinc Sheets are unchanged from prices in the Feb. 9 issue.

Refractories

Chrome Brick, Fireclay Brick, Magnesite Brick, Silica Brick and Zirkite are unchanged from quotations in the issue of Feb. 9.

Iron, Steel and Coke

Iron—Per gross ton, Valley furnaces, Bessemer, $18@$18.25; basic, $17.50; No. 2 foundry, $17.50.

Steel—Base prices per gross ton, Pittsburgh, billets and slabs, $33; plates, structural shapes, and soft steel bars, per lb., $1.90.

Coke—Per gross ton, Connellsville furnace, $2.85@$2.90. Connellsville foundry, $3.75@$4.85. Byproduct coke, Ohio and Kentucky, $7; Buffalo and Detroit, $8.50@$9.

Mining Stocks—Week Ending Feb. 16, 1929

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	136⅛	127	128⅛	Mr.29,My.20	Q 1.75
Andes Copper	New York	57½	50⅜	54	No. 15, De. 17	I 0.75
Arizona Com	Boston	4⅜	4	4	Ja. 16, Ja. 31	S.A.0.25
Calumet & Ariz	New York	134½	126⅛	127⅜	De. 1, De. 17	QX 2.50
Calumet & Hecla	Boston	59½	56⅛	56⅛	Fe. 28, Mr. 30	Q 1.00
Cerro de Pasco	New York	113⅜	105½	105⅜	Ja. 11, Fe. 1	Q 1.25
Chile Copper	New York	99⅛	91⅛	93⅜	Mr.22, Ap.22	Q 0.87½
Con. Coppermines	N. Y. Curb	14⅜	13⅛	13⅜		
Copper Range	Boston	29⅜	27⅛	27⅛	De. 15, Ja. 15	0.50
East Butte	Boston	4	3⅜	3⅜	Dec., 1919	0.50
Granby Con	New York	94⅞	87½	88⅜	Ja. 4, Fe. 1	Q 1.00
Greene Cananea	New York	182½	170	170	De. 1, Ja. 7	Q 1.50
Howe Sound	New York	76⅛	69⅞	70	De. 31, Ja. 5	Q 1.00
Hudson Bay	N. Y. Curb	23	21	21		
Inspiration	New York	56⅞	51	51⅛	De. 20, Ja. 7	R 0.75
Isle Royale	Boston	28⅛	27	27⅛	Fe. 28, Mr. 30	X 0.50
Kennecott	New York	165⅛	152⅜	154⅛	No. 30, Ja. 2	Q 2.00
Magma Copper	New York	75⅛	69⅛	69⅛	De. 31, Ja. 15	Q 1.00
Mason Valley	N. Y. Curb	1⅛	1⅛	1⅛		
Miami Copper	New York	43⅛	38⅛	39⅛	Fe.1, Fe.15	Q 0.50
Mohawk	Boston	46	43⅛	44	Ja. 26, Mr. 1	Q 1.50
Mother Lode	New York	5	3⅛	4⅛	De.14, De.31	SA 0.20
Nevada Con	New York	51⅛	46⅜	47⅛	De.14, De.31	Q 0.50
New Cornelia	N. Y. Curb	45⅛	41⅛	42⅛	Fe. 1, Fe. 18	Q 0.50
Noranda	N. Y. Curb	64	59½	59⅛		
Ohio Copper	N. Y. Curb	3⅜	3⅛	3⅛	Sept., 1926	0.03
Old Dominion	Boston	17⅛	16⅛	16⅜	Dec., 1918	1.00
Phelps Dodge	N. Y. Curb	375	308	308	De. 18, Ja. 2	Q 2.50
Quincy	Boston	48	44⅛	44⅛	March, 1920	1.00
Roan Antelope	N. Y. Curb	47	43⅛	43⅛		
St. Mary's M. L	Boston	41	38	39	No.20, De.1	X 1.00
Seneca Copper	New York	6½	5⅞	6		
Shattuck Denn	N. Y. Curb	23	21⅛	22		
Sherritt-Gordon	Toronto	....	....	8.10		
Tenn. C. & C	New York	20⅜	18⅛	18⅛	Fe.28, Mr.15	Q 0.25
United Verde Ex	N. Y. Curb	22⅛	20⅛	20⅛	Ja. 4, Fe. 1	Q 0.75
Utah Copper	New York	290	285	285	De. 14, De. 31	Q 3.00
Waite-Ack.-Mont	Toronto	....	....	2.35		
Walker Mining	Salt Lake	2.75½	2.60	2.75		
Wenden Copper	N. Y. Curb	2⅛	1⅞	2		
LEAD, ZINC, SILVER						
Ahumada Lead	New York	4⅛	3⅞	4		
Amer. Z. L. & S	New York	42	35⅛	35⅛	May, 1917	1.00
A. Z. L. & S., pfd	New York	105	101	101	Nov., 1920	1.50
Bingham Mines	Boston	53	51⅛	51⅛	De. 20, Ja. 5	Q 0.50
Bunker Hill & S	N. Y. Curb	142	136	142	Ja. 31, Fe. 5	X 0.75
Butte Cop. & Zn	New York	8⅞	8⅛	8⅛		
Butte Cop. Con	Boston Curb	*97	*90	*94		
Butte & Sup	New York	10⅛	9	9⅛	Dec. 31,	Q 0.50
Callahan Zn-Ld	New York	3⅜	3	3⅛	Dec., 1920	0.50
Chief Consol	Salt Lake	3.55	3.40	3.42½	Fe. 1, 1928	K 0.10
Consol. Ld. & Zn. "A"	St. Louis	12	11⅛	11⅛	Ja. 1	K 0.25
Constitution	Spokane	*28	*25	*25		
Dayrock	Spokane	1.85	1.70	1.85		
Dickens Consol	Spokane	*24⅜	*19	*24⅜		
Eagle-Picher	Cincinnati	20½	20	20	No. 15, De. 1	Q 0.40
Eagle-Pich., pfd	Cincinnati	102	102	102	Jan. 15	Q 1.50
Erupcion	Boston Curb	....	....	*29	Ja. 1, 1928	Q 0.07½
Eureka Bullion	Salt Lake	*72	*66	*66		
Eureka Lily	Salt Lake	....	....	1.42½		
Eureka Standard	Salt Lake	....	....	4.83		
Evans-Wallower	N. Y. Curb	24⅞	21⅛	21⅛		
Evans-Wal., pfd	N. Y. Curb	88	88	88	Jan. 15,	I 1.75
Federal M. & S	New York	....	....	300	Je., 1927	10.00
Fed. M. & S., pfd	New York	109	107½	107½	Fe. 21, Mr. 15	Q 1.75
Gladstone	Spokane	*15	*14	*14		
Golconda	Spokane	1.52	1.24	1.50		
Grandview	Spokane	*74	*68	*69		
Hecla Mining	N. Y. Curb	17⅛	16⅜	16⅜	Fe.15, Mr.15	M 0.15
Highland-Surprise	Spokane	*15¼	*14¼	*14¼		
Jack Waite	Spokane	*21	*19½	*20¼		
Kootenay Florence	Spokane	*23½	*21½	*21½		
Lucky Jim	Spokane	*19	*18½	*18½		
Lucky Tiger-C	Kansas City	†5.75	†5.50	....	De.4, De.20	MX 0.12
Mexican Premier	Spokane	1.29	1.20	1.29		
National Lead	New York	147⅛	141½	141⅛	De. 14, De. 31	Q 1.25
Natl. Lead, pfd. A	New York	140	140	140	Mr. 1, Mr. 15	Q 1.75
Natl. Lead, pfd. B	New York	118⅛	118	118	Ja. 18, Fe. 1	Q 1.50
N. J. Zinc	N. Y. Curb	310	306½	308		
N. J. Zinc, new	N. Y. Curb	80⅜	77⅛	77⅛		
New Quincy	Salt Lake	1.50	1.42½	1.50		
Noble Five	Spokane	*66	*65	*65		
North Lily	Salt Lake	8.75	8.50	8.59	Jan. 20	Q 0.25
Park Bingham	Salt Lake	*12	*11	*11		
Park Utah	New York	13⅛	11⅛	11⅛	De. 31, Ja. 2	Q 0.20
Pend Oreille	Spokane	14.50	12.00	13.75		
Rico Argentine	Salt Lake	*49	*48	*48⅛	No. 30, De. 15	Q 0.03
Ruth-Hope	Spokane	*51	*50	*51		
St. Joseph Lead	New York	79⅛	70½	71½	Ma. 8, Ma.20	QX 0.75
Sherman Lead	Spokane	*26	*24	*26		
Silver King Coa	Salt Lake	14½	13⅛	14⅛	De. 15, Ja. 2	Q, 0.25
Silversmith	Spokane	*17⅛	*15⅛	*17	Oct., 1926	Q 0.02
Sunshine Mining	Spokane	1.54	1.48	1.48	De. 20,	BM 0.02
Tamarack-Custer	Spokane	*40	*35	*39⅛	Sept., 1924	0.25
Tintic Standard	Salt Lake	14⅛	14	14⅛	De. 23, Ja. 23	X 0.20
Tonopah Belmont	N. Y. Curb	1⅛	1 1/16	1 1/16	Oct., 1925	0.05
Treadwell-Yukon	Toronto	12⅜	12	12		
United Zinc Smg	N. Y. Curb	1⅜	1⅛	1⅜		
Utah Apex	Boston	5	4⅛	4⅛	Je. 14, Au. 1	K 0.25
Utah Met. & Tun	Boston	1⅛	1⅛	1⅛	Dec., 1917	0.30
Whitewater	Spokane	1.15	1.10	1.15		
Yellow Pine	Los Angeles	*5	*5	*5	Dec., 1925	QX 0.04
GOLD						
Alaska Juneau	New York	8⅛	7⅛	7⅛		
Barry-Hollinger	Toronto	*32	*29½	*30½		
Central Manitoba	Toronto	*65	*60	*63		
Coniaurum	Toronto	1.75	1.75	1.75		
Cresson Consol	N. Y. Curb	*99	*93	*93	Jan. 15,	Q 0.02
Dome Mines	New York	10½	9½	9⅝	De. 21, Ja. 21	Q 0.25
Golden Cycle	Col. Springs	†1.62	†1.60	....	No. 30, De. 10	Q0.04
Gold Hill	Toronto	*9⅜	*6	*8⅛		
Hollinger	Toronto	9.00	8.50	8.60	Fe. 8, Fe.25	M 0.05
Homestake	New York	73½	73	73½	Fe.20, Fe.25	MX 0.50
Kirland Lake	Toronto	1.65	1.42	1.45		
Lake Shore	Toronto	21.00	20.00	20.90	Mr.1, Mr.15	Q 0.20
McIntyre-Porc	New York	....	....	20½	Fe.1, Mr.1	Q 0.25
Portland	Colo. Springs	†*12	†*9⅛	....	April, 1927	0.02
Rand Mines	New York	36½	36⅛	36⅛	Au.21,'28	Am.Sh.1.52
Siscoe	Toronto	....	....	1.35		
Sylvanite	Toronto	2.20	2.10	2.20		
Teck-Hughes	Toronto	9.20	8.70	9.15	Ja. 31, Fe. 1	Q 0.15
Tom Reed	Los Angeles	*30	*30	*30	Dec., 1926	0.02
Unity Gold	N. Y. Curb	1⅛	1⅛	1⅛		
Vipond Consol	Toronto	1.25	1.10	1.19	April, 1927	0.03
Wright-Hargreaves	Toronto	2.14	2.00	2.05	Oc. 16, No. 1	0.02½
Yukon-Alaska	N. Y. Curb	33⅛	33	33⅛		
GOLD AND SILVER						
Carnegie Metals	N. Y. Curb	18⅞	17⅛	18		
Castle-Trethewey	Toronto	*38	*36	*36		
Cent. American	N. Y. Curb	....	....	....		
Consol. Cortez	N. Y. Curb	*25	*25	*25		
Dolores Esperanza	N. Y. Curb	1⅛	1	1⅛	July, 1923	0.05
Keeley	Toronto	*58	*54	*54	Mr.15, 1928	0.04
Mining Corp	Toronto	5.50	4.90	5.05	De.14,De.31	SA 0.15
Montana-Idaho	Spokane	*10⅛	*9	*9⅛		
N. Y. & Hond. Ros	N. Y. Curb	17	16⅛	16⅛	Ja.16, Ja.26	QX 0.50
Nipissing	N. Y. Curb	3⅛	3	3⅛	Mr.30,Ap.20	Q 0.07½
Premier Gold	N. Y. Curb	....	....	2⅛	De. 14, Ja. 4	Q 0.06
Tonopah Exten	N. Y. Curb	*16	*14	*14	April, 1925	0.05
Tonopah Mining	N. Y. Curb	....	....	3 1/16	Se. 29, Oc. 20	SA 0.07½
United Eastern	N. Y. Curb	*91	*91	*91		
Yukon Gold	N. Y. Curb	*91	*90	*90	June, 1918	0.02
IRON AND STEEL						
Bethlehem Steel	New York	93⅛	87	88⅛	Fe. 15,	R 1.00
Beth. Steel, pfd, 7%	New York	122⅛	121⅛	121⅛	Mr.4, Ap.1	Q 1.75
Cleveland-Cliffs	Cleveland	140	135	139	Ja.15, Ja.25	QX 2.00
Colo. Fuel & Iron	New York	70	65	65		
Colorado F. & I., pfd	New York	....	....	133⅛	Fe.11, Fe.25	Q 2.00
Great Northern Iron	New York	36⅛	33	34	Dec.15,	K 2.00
Inland Steel	New York	89	83	86	Fe. 15, Mr. 1,	Q 0.87½
Republic I. & S	New York	86⅞	80	82⅛	Fe. 13, Mr. 1,	Q 1.00
Republic I. & S., pfd	New York	111⅛	110⅛	110⅛	Mr.11, Ap. 1,	Q 1.75
Sloss-Sheffield S. & I	New York	118	114⅛	114⅛	De. 15,	Q 1.50
Sloss-Sheff. S. & I., pfd.	New York	107½	107½	107½	De.20, Ja.2	Q 1.75
U. S. Steel	New York	180	168⅛	169⅜	Fe. 28, Mr. 30,	Q 1.75
U. S. Steel, pfd	New York	141⅛	141	141	Fe 2, Fe. 27,	Q 1.75
Virginia I. C. & C	New York	....	....	25	Jan., 1924	1.50
Virginia I.C.& C., pfd.	New York	48	48	48	Jl.16, 1928	SA2.50
MISCELLANEOUS						
Aluminum Co. of Am.	N. Y. Curb	174½	162	163		
Alum.Co.of Amer., pf.	N. Y. Curb	105½	105½	105⅛	Mr.15, Ap.1,	Q 1.50
American Metal	New York	78⅛	71⅛	72⅛	Fe.9, Mr.1	Q 0.75
Amer. Metal, pfd., 6%	New York	131⅛	122	122	Fe.9, .Mr.1,	Q 1.50
Amer.Sm. & Ref	New York	120⅜	111	111⅜		
Amer. Sm. & Ref., pfd.	New York	136⅛	135⅛	136⅛	Fe. 1, Mr. 1	Q 1.75
Amer. Sm. & Ref., new	N. .Y. Cuab	....	....	114⅛		
Ang. Ch. Nitrate	N. Y. Curb	38	35⅛	35⅛		
Asbestos Corp	Montreal	19⅛	18	19⅛	Jan. 1926	1.50
Asbestos Corp., pfd	Montreal	62⅛	61	62	De. 31, Ja. 15	Q 1.75
Consol. M. & S	Montreal	510	409	409	De.31,Ja.15,SA	X6.25
De Beers Consol	New York	22	22	22	Ja. 19, Ja.26,	0.48
Federated Metals	N. Y. Curb	34	32⅛	33⅛		
Freeport Texas	New York	49	45⅛	46⅛	Ja. 15, Fe. 1	Q 1.00
Int. Nickel Can., new	New York	65⅛	58	59⅛		
Int. Nickel, pfd	New York	122	122	122	Ja. 18, Fe. 1	Q 1.75
Newmont	N. Y. Curb	200⅛	188	188	De. 28, Ja. 15	Q 1.00
Patiño M. & E	New York	38⅛	36	36⅛	Aug. 1928	4s.
So. America G. & P	N. Y. Curb	2⅛	2⅛	2⅛		
Texas Gulf Sulphur	New York	76⅛	72⅛	72⅛	De. 1, De. 15	Q 1.00
U. S. Sm. R. & M	New York	69⅞	65	65	De. 31, Ja. 15	Q 0.87½
U. S. Sm. R. & M., pfd.	New York	56	55⅛	55⅛	De. 31, Ja. 15	Q 0.87½
Vanadium Corp	New York	114	101	101⅛	Fe. 1, Fe. 15	Q 0.75

Toronto Standard Stock Exchange, Toronto, courtesy Arthur E. Moysey & Co.; Salt Lake Stock Exchange, courtesy J. A. Hogle & Co. and Logan & Bryan, New York; Spokane Stock Exchange, courtesy Pohlman Investment Company.

*Cents per share. †Bid or asked. Q, Quarterly. A. Annually. SA, Semi-annually. M, Monthly. BM, Bimonthly. FW, Four weeks. K, Irregular. I, Initial. R, Resumprion. X, Extra. The first data given is that of the closing of the books; the second that of the payment of the dividend.

LONDON QUOTATIONS—WEEK ENDED FEBRUARY 5, 1929

	High	Low	Last	Date	Amount
Alaska Mexican ($5)	12/6	12/—	12/—		
Alaska Treadwell (25)	55/—	50/—	50/—	Nov., 1926	4 (d)
Armayo Mines (25 frs.)	66/3	63/9	63/9	Nov. 1928	5 (c)
Burma Corp (10 rupees)	18/4½	17/3	18/—	Feb., 1929	7 annas*
Bwana M'Kubwa (5s)	23/4½	19/—	22/10½		
Camp Bird (2s)	3/9	3/3	3/6	April, 1928	16⅜
El Oro (£1)	5/7½	5/3	5/6	Nov., 1924	2½*
Frontino & Bolivia (£)	9/1½	8/10½	9/—	July, 1928	3½
International Nickel of Canada (no par value)	$70½	$64½	$64½		
Mexican Corpn. (£1)	12/6	11/3	12/3		
Mexican Mines of El Oro (£1)	25/—	2/6	15/—	Dec., 1926	3½*
Mount Isa (£)	42/6	40/—	41/10½		
N'Changa Copper Mining. (£1)	81/3	55/7½	72/6		
Oroville Dredging (4s)	3/—	2/9	3/—	Nov., 1928	31½
Rhodesian Congo Border (£1)	90/—	69/4½	83/9		
St. John del Rey (£1)	12/—	11/9	12/—	Dec., 1928	2½
San Francisco Mines (10s)	36/—	33/3	35/6	Jan., 1929	25
Santa Gertrudis (£1)	12/10½	12/3	12/6	Jan, 1929	7½
Selukwe (2s. 6d.)	8/3	7/—	8/—	April, 1927	6⅜
S. Amer. Copper (2s.)	3/1½	2/9	2/10½	Nov. 1917	75
Tanganyika (£1)	74/6	69/—	72/—	July, 1928	5
Union Miniere de Haut-Katanga (Brussels)	12,100	11,650	12,100	July, 1928	182.60‡

*Free of British income tax. †Swiss francs and plus 15 p. c. bonus. ‡Belgian frs. and free of taxation.

(Price quoted in dollars with a fixed rate of $5 to the £1)